

## SECTION 801 — CEMENT

**801.01 REQUIREMENTS.** Provide portland cement from approved mills listed in the Department's List of Approved Materials. Mills obtain approval by furnishing the Department samples and certified mill test data developed over the previous 6 months. Approved cement mill laboratories are AASHTO accredited in ASTM C150 test methods.

Conform to the following requirements for cement:

- 1) Type I, II, III, and IV conforms to ASTM C 150. State, in writing, the nature, amount, and identity of any processing addition and its compliance with ASTM C 465.
- 2) Type K conforms to ASTM C 845.
- 3) Type IP or Type IPA conforms to ASTM C 595, and the following additional requirements to Type IP and IPA:
  - a) The pozzolan constituent shall be fly ash. Ensure that the loss on ignition of the fly ash does not exceed 3.0 percent.
  - b) Ensure that the fly ash does not exceed 20 percent of the portland-pozzolan cement, by weight. The cement manufacturer shall furnish a statement to the Engineer stating the actual fly ash content in each shipment.
  - c) The cement manufacturer shall furnish to the Engineer reports showing the results of tests performed on the fly ash used in the manufacture of the Type IP cement shipped to the project. The tests shall cover the chemical and physical properties listed in ASTM C 618.
  - d) The cement manufacturer shall have a qualified technical representative readily available for consultations on the project at any time the Engineer deems necessary, at no expense to the Department.
  - e) Use only one brand of Type IP cement throughout the project, unless the Engineer approves a change in brand in writing.

Even when tested and approved, do not mix cement from different mills in individual batches or use cement from different mills in alternate batches of concrete. Subject to the above restrictions, the Engineer may allow the use of cements from different mills for any structure or individual elements of a structure, provided color contrasts resulting from their usage is minimal or is otherwise unobjectionable and identification of the location of concrete containing the different cements is satisfactorily maintained.

Store cement to prevent damage from the elements. Provide weatherproof storage facilities with sufficient storage capacity that cements from different mills or of different types will not become intermixed.

Provide an acceptable means for obtaining samples, from either the cement silo, weigh hopper, or truck.

The Engineer will reject cement that for any reason has become damaged through contamination, partial set, or which contains lumps of caked cement. The Engineer may reject the entire contents of a container when it contains damaged cement.

The Engineer may accept cement producing an air content of mortar between 12 and 16 percent when it is to be used in air-entraining concrete and the air content of the concrete is controlled at the mixer.

**801.02 NON-SPECIFICATION CEMENT.** The Department accepts cement on the basis of manufacturer's certification attesting to type and conformance to the applicable ASTM specification. The Engineer will take check samples. When the check samples do not conform to these specifications, the Department will make deductions as shown in the following table. When a sample fails more than one test, the Department will make the total deduction as the sum of deductions up to a maximum of 100 percent.

TEST	MAXIMUM DEVIATION FROM REQUIREMENT (PERCENT)	DEDUCTION RATE BASED ON INVOICE COST OF CEMENT
Autoclave Expansion	0.08	12.5% per 0.01% deviation
Fineness by air permeability	10	20% per 2% deviation
Air Content for Air Entrained Cement	$\pm 4$	25% per 1% deviation
Air Content for Non-Air Entrained Cement	$\pm 8$	0-4 free, thereafter 25% Per 1% Deviation
Compressive Strength	15	20% per 3% deviation
Time of Set	20	25% per 5% deviation
Magnesium Oxide (MgO)	0.3	33.3% per 0.1% deviation
Sulfur Trioxide (SO <sub>3</sub> )	0.4	0.1% free and then 33.3% per 0.1% deviation
Loss on Ignition	0.75	20.0% per 0.15% deviation
Insoluble Residue	0.75	20.0% per 0.15% deviation
Tricalcium Aluminate (C <sub>3</sub> A)	1.5	33.3% per 0.5% deviation
Silicon Dioxide (SiO <sub>2</sub> )	3.0	33.3% per 1% deviation
Aluminum Oxide (Al <sub>2</sub> O <sub>3</sub> )	1.0	20.0% per 0.2% deviation
Ferric Oxide (Fe <sub>2</sub> O <sub>3</sub> )	1.0	20.0% per 0.2% deviation

## SECTION 802 — ADMIXTURES FOR CONCRETE

**802.01 REQUIREMENTS.** Provide admixtures conforming to the following requirements:

**802.01.01 Air-Entraining.** AASHTO M 154, except the chloride content (as Cl) shall not exceed one percent by weight. The Department may require tests for bleeding, time of setting, and length change.

**802.01.02 Water-Reducing and Retarding.** AASHTO M 194, Type D, except the relative durability factor shall not be less than 90 and the chloride content (as Cl) shall not exceed one percent by weight.

**802.01.03 Water-Reducing.** AASHTO M 194, Type A, except the relative durability factor shall not be less than 90 and the chloride content (as Cl) shall not exceed one percent by weight.

**802.01.04 Water-Reducing and Accelerating.** AASHTO M 194, Type E, except the relative durability factor shall not be less than 90 and the chloride content (as Cl) shall not exceed one percent by weight. Use water reducing and accelerating admixture only when the Engineer has reviewed proposed procedures for mixing, handling, and placing the concrete, and has given written permission to proceed.

**802.01.05 Water-Reducing, High Range.** AASHTO M 194, Type F, except the relative durability factor shall not be less than 90 and the chloride content (as Cl) shall not exceed one percent by weight.

**802.01.06 Water-Reducing, High Range and Retarding.** AASHTO M 194, Type G, except the relative durability factor shall not be less than 90 and the chloride content (as Cl) shall not exceed one percent by weight.

**802.01.07 Accelerating.** AASHTO M 194, Type C, except the relative durability factor shall not be less than 90 and the chloride content (as Cl) shall not exceed one percent by weight.

**802.02 APPROVAL.** Select admixtures from the Department's List of Approved Materials. The Department places admixtures on the list based on evidence of compliance with requirements when determined by either tests performed by the Department; certified test data furnished by a recognized laboratory providing such laboratory shall be one regularly inspected by the Cement and Concrete Reference Laboratory of ASTM; for air-entraining admixtures that are aqueous solutions of Vinsol Resin, manufacturer's shall submit a certification in the following form:

*This is to certify that the product (trade name) as manufactured and sold by (company) is an aqueous solution of Vinsol Resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to Vinsol Resin is one part of sodium hydroxide to (number) parts of Vinsol Resin. The percentage of solids based on the residue dried at 105 EC is (number). No other additive or chemical agent is present in this solution.*

The Engineer will not require testing of admixtures included on the Department's List of Approved Materials at the time of their use unless there is indication in actual field use of harmful effects on the properties of the concrete or when the Engineer considers testing necessary for other reasons.

The Department will continue to include an admixture on the list contingent upon

satisfactory performance in actual project use and an annual certification containing the following information:

- 1) A statement that the admixture to be furnished during the particular calendar year is of the same composition as that previously approved for inclusion on the approved list.
- 2) A statement that the admixture conforms to the appropriate requirements of AASHTO M 194 or AASHTO M 154, as applicable.
- 3) A statement that the chloride content (as Cl) does not exceed one percent by weight.
- 4) A statement that notification will be made to the Division of Materials of any changes in composition before furnishing the material to projects.

The Department provides the specific details governing verification and documenting approved status of admixtures at the time of use in the Department's Manual of Field Sampling and Testing Practices.

## SECTION 803 — WATER

**803.01 GENERAL.** Use water for mixing or curing concrete, emulsified asphalt, or other similar materials that is reasonably clean and free from oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. The Engineer may test the water at any time for its suitability for a particular use.

The Engineer will ordinarily accept water supplied by public distribution systems without testing.

The Engineer will require testing of mixing water for use in concrete when not from a public distribution system.

Provide water that when tested by KM 64-226 does not contain impurities in excess of the following limits:

Acidity or Alkalinity Calculated in terms of Calcium Carbonate	0.05 Percent
Total Organic Solids	0.10 Percent
Total Inorganic Solids	0.10 Percent
Chloride Content (as Cl)	1,000 parts per million

## SECTION 804 — FINE AGGREGATES

**804.01 GENERAL.** Fine aggregates include, but at the discretion of the Engineer are not limited to, natural sand, crushed sand, conglomerate sand, mortar sand, mineral filler, and lightweight aggregates where permitted.

The Department's List of Approved Materials includes the Aggregate Source List and the list of Class A and Class B Polish-Resistant Aggregate Sources.

**804.01.01 Natural Sand.** Provide fine granular material resulting from the natural disintegration of rock.

**804.01.02 Crushed Sand.** Provide fine granular material resulting from crushing of stone or gravel. Includes slag where permitted.

**804.01.03 Conglomerate Sand.** Provide natural materials primarily processed to the desired sizes, without crushing. Conglomerate sand may include some crushed natural material.

**804.01.04 Mortar Sand.** Provide natural, crushed, or conglomerate sand suitable for use in cement mortar.

**804.01.05 Mineral Filler.** Provide limestone dust, cement, fly ash, or other inert mineral matter.

**804.02 APPROVAL.** Provide fine aggregates from sources included on the Aggregate Source List meeting the description and requirements specified in this section.

The Department will consider a source for inclusion on the Aggregate Source List when the aggregate producer provides the following:

- 1) A Quality Control Plan.
- 2) A satisfactory laboratory facility with all necessary testing equipment.
- 3) A Qualified Aggregate Technician to perform the required testing.

When a supplier wishes to supply sand only for asphalt mixtures, Items 1, 2 and 3 above will be waived. The Department may add the source to the Aggregate Source List and restrict its use to asphalt mixtures.

Obtain the Department's approval before furnishing aggregate from sources not on the Aggregate Source List. The Department will sample the aggregate during stockpiling and test according to the Department's Manual of Field Testing and Sampling Practices.

The Department will reject aggregate when excessive variation of gradation or physical properties cause unworkable mixtures, mixture control problems, or non-conformance to the finished product or mixture requirements.

The Department will reject contaminated aggregate when the Engineer deems it could be detrimental to the finished product.

**804.03 CONCRETE.** Provide natural, crushed, or conglomerate sand. The Department will allow any combination of natural, crushed, or conglomerate sand when the combination is achieved in the concrete plant weigh hopper. The Engineer may allow other sands.

Use natural or conglomerate sands as fine aggregates in concrete intended as a wearing surface for traffic.

Conform to the following:

- 1) Sand Equivalent - 80 (minimum).
- 2) Soundness - 10% loss (maximum).
- 3) Friable Particles - 1.0% (maximum).

- 4) Coal plus Lignite - 0.50% (maximum).
- 5) Uncompacted Voids<sup>(1)</sup> - 47% (maximum).
- 6) Organic Impurities - Not darker than the standard.
- 7) Mortar Strength<sup>(2)</sup> - 95% at 7 calendar days (minimum).
- 8) Gradation<sup>(1)</sup>:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	90-100
No. 16	45-85
No. 50	5-25
No. 100	0-8

- <sup>(1)</sup> *The Department will permit fine aggregates exceeding when they are used in a combination that meets requirements.*
- <sup>(2)</sup> *The Department will require testing for mortar strength only for sand not passing the test for organic impurities and will supersede the requirement for organic impurities.*

The Department will waive the requirements for gradation, sand equivalent, and uncompacted voids for precast reinforced concrete box culvert sections, concrete pipe, and pipe arches.

**804.04 ASPHALT MIXTURES.** Provide natural, crushed, conglomerate, and slag sand, with the addition of filler as necessary, to meet gradation requirements. The Department will allow any combination of natural, crushed, conglomerate, and slag sand when the combination is achieved using cold feeds at the plant.

**804.04.01 Sand for Mixtures.**

- 1) Gradation - 100 percent passing the 3/8 inch sieve with more than 50 percent passing the No. 4 sieve.
- 2) Coal Plus Lignite - 5.0 percent maximum.
- 3) Soundness - 15 percent maximum.

**804.04.02 Mineral Filler.** Ensure 100 percent passes the No. 16 sieve and at least 30 percent passes the No. 200 sieve.

**804.04.03 Polish-Resistant Aggregate.** Provide fine aggregates required for polish-resistant applications from a Class A Polish-Resistant Aggregate Source. In addition to these listed sources, the Department will consider natural sand, conglomerate sand, and crushed gravel sand meeting the requirements of Section 804 to be polish-resistant.

**804.04.04 Requirements for Combined Aggregates.**

- A) **Uncompacted Voids.** Provide aggregates for Superpave mixtures meeting the minimum voids content as listed in the Superpave Fine Aggregate Consensus Property Requirements table.
- B) **Sand Equivalent.** Provide aggregate having a sand equivalent value of 45 or greater for the portion of the total combined aggregates passing the No. 4 sieve. Provide aggregates for Superpave mixtures meeting the minimum sand equivalent limits as listed in the Superpave Fine Aggregate Consensus Property Requirements table.

The sand equivalent limits specified in this section apply to aggregates in the final mixture. The Department will normally take samples from stockpiled aggregates or aggregate cold feeds, including mineral filler, for acceptance testing. When these tests do not meet the required values, make trial runs through the plant to provide material for sampling which is intended for the final mixture.

Except for Superpave mixtures, the Department may waive the sand equivalent requirement provided the portion of the combined aggregate passing the No. 40 sieve is non-plastic according to AASHTO T 90.

<b>SUPERPAVE FINE AGGREGATE CONSENSUS PROPERTY REQUIREMENTS</b>				
ESAL Class	Design ESALs (millions)	Uncompacted Void Content of Fine Aggregate (Percent), <sup>(1)</sup> Minimum (Depth From Surface)		Sand Equivalent (Percent), Minimum
		≤ 100 mm	> 100 mm	
1	< 0.3	-	-	45
2	0.3 to < 3	40	40	45
3	3 to < 30	45	40	45
4	≥ 30	45	45	50

<sup>(1)</sup> Performed according to AASHTO T 304, Method A.

- C) Friable Particles.** Limit friable particles, excluding sandstone, to a maximum of 1.0 percent of the total combined aggregates.
- D) Absorption.** Provide aggregates having a water absorption of no more than 3.0 percent for each aggregate type. When slag is used, provide total combined aggregates having a water absorption of no more than 4.0 percent.

**804.05 MORTAR SAND.** Provide natural sand, crushed sand, or conglomerate sand conforming to Subsection 804.03 with the exception of Uncompacted Voids and Gradation. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 8	100
No. 50	10-40
No. 100	0-10

**804.06 EPOXY SEAL COATS.** Provide either natural or conglomerate sand having an insoluble content of 90 percent or greater. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 16	100
No. 50	10-40
No. 100	0-5

**804.07 EPOXY SAND SLURRY.** Provide silica sand containing no less than 90 percent insolubles. Ensure the sand is rounded to subangular, clean, dry and non-friable. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 8	100
No. 50	0-40
No. 100	0-5

The Department may allow material not meeting this gradation if it produces a workable mixture and an acceptable slurry seal.

**804.08 PIPE BEDDING.** Provide natural, crushed, or conglomerate sand having a



sand equivalent of 20 or greater. The Department may waive the sand equivalent requirement when the portion passing the No. 40 sieve is non-plastic according to AASHTO T 90. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 100	0-15

**804.09 UNDERDRAINS, EMBANKMENT DRAINAGE BLANKET, AND NATURAL SAND FOR DRAINAGE AND BACKFILL.** Provide natural sand having a sand equivalent of 70 or greater. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	75-100
No. 100	0-8

**804.10 GRADATION ACCEPTANCE OF NON-SPECIFICATION FINE AGGREGATE.** When reasonably acceptable work has been produced using the aggregate in question, the Department may accept the work according to Subsection 105.04. When the Engineer determines that the aggregate not conforming to gradation requirements may be left in place, the Department will accept the aggregate at a reduction in the Contract unit bid price for the work containing the aggregate according to the following procedures. The Department will not consider these procedures a means to continue accepting non-specification aggregates.

The Department will base the reduction on the invoice price for the aggregate at the source. When satisfactory invoices are not furnished, the Department will use current bin prices for that source on file with the Cabinet's Division of Purchases. The maximum deduction for non-specification material, which is allowed to remain in place, is 50 percent.

When aggregate fails to conform to gradation on more than one sieve, the Department will apply the largest payment reduction.

The Department will define a lot based on the smallest definable quantity of material represented by acceptance test results, either passing results or failing results, or both. Normally, the Department will average all test results for the lot to determine the test result for payment according to the deduction tables. However, when test results are not reasonably uniform the Department will not average the high and low test results within a lot. The Department will assign each test result to equal quantities in new smaller lots in proportion to the number of tests representing the original lot. When daily tests are performed, the lot will be a day's production unless the Department defines a smaller lot.

When 2 consecutive lots contain non-specification material, discontinue the use of the aggregate until the Department makes a decision concerning the overall acceptability of the aggregate from that source.

The Department will not impose a reduction in payment for quantities less than 50 tons unless the Engineer deems it necessary.

GRADATION - CONCRETE SAND					
Payment Reduction	Sieve Size-Percent Passing				
	3/8 inch	No. 4	No. 16	No. 50	No. 100
0%	100	90-100	45-85	5-25	0-8
10%			43-44	3-4	
10%	98-99	88-89	86-87	26-27	9
20%			42	2	
20%	97	87	88	28	10
30%			41	1	
30%	96	86	89	29	11
50%			40	0	
50%	95	85	90	30	12

GRADATION - MINERAL FILLER		
Payment Reduction	Sieve Size-Percent Passing	
	No. 16	No. 200
0%	100	30 minimum
10%	98-99	29
20%	97	28
30%	96	27
50%	95	26

GRADATION - MORTAR SAND			
Payment Reduction	Sieve Size-Percent Passing		
	No. 8	No. 50	No. 100
0%	100	10-40	0-10
10%		8-9	
10%	98-99	41-42	11
20%		7	
20%	97	43	12
30%		6	
30%	96	44	13
50%		5	
50%	95	45	14

<b>GRADATION - SAND FOR EPOXY SEAL COAT</b>			
Payment Reduction	Sieve Size-Percent Passing		
	No. 16	No. 50	No. 100
0%	100	10-40	0-5
10%		8-9	
10%	98-99	41-42	6
20%		7	
20%	97	43	7
30%		6	
30%	96	44	8
50%		5	
50%	95	45	9

<b>GRADATION - PIPE BEDDING</b>		
Payment Reduction	Sieve Size-Percent Passing	
	3/8 inch	No. 100
0%	100	0-15
10%	98-99	16
20%	97	17
30%	96	18
50%	95	19

<b>GRADATION - UNDERDRAINS, EMBANKMENT DRAINAGE BLANKET, AND NATURAL SAND FOR DRAINAGE AND BACKFILL</b>			
Payment Reduction	Sieve Size-Percent Passing		
	3/8 inch	No. 4	No. 100
0%	100	75-100	0-8
10%	98-99	73-74	9
20%	97	72	10
30%	96	71	11
50%	95	70	12

**804.11 SAMPLING AND TESTING.** The Department will sample and test according to the following methods when applicable:

Absorption (Fine Aggregate)	AASHTO T 84
Coal and Lignite	KM 64-615
Dry Sieve Analysis	AASHTO T 27
Friable Particles	AASHTO T 112
Insoluble Content (Fine Aggregate)	KM 64-224
Mortar Strength	AASHTO T 71
Organic Impurities	AASHTO T 21
Plastic Limit and Plasticity Index	AASHTO T 90
Sampling	AASHTO T 2
Sand Equivalent	AASHTO T 176
Sieve Analysis of Mineral Filler	AASHTO T 37
Soundness	KM 64-610
Uncompacted Voids (Method A)	AASHTO T 304
Wet Sieve Analysis	KM 64-620 or AASHTO T 27

## SECTION 805 — COARSE AGGREGATES

**805.01 GENERAL.** Coarse aggregates include, but at the discretion of the Engineer are not limited to, crushed stone and crushed or uncrushed gravel. Includes lightweight aggregates or slag where permitted.

The Department's List of Approved Materials includes the Aggregate Source List and the list of Class A and Class B Polish-Resistant Aggregate Sources.

**805.02 APPROVAL.** Provide coarse aggregates from sources included on the Aggregate Source List meeting the description and requirements specified in this section.

The Department will consider a source for inclusion on the Aggregate Source List when the aggregate producer provides the following:

- 1) A Quality Control Plan.
- 2) A satisfactory laboratory facility with all necessary testing equipment.
- 3) A Qualified Aggregate Technician to perform the required testing.

Obtain the Department's approval before furnishing aggregate from sources not on the Aggregate Source List. The Department will sample the aggregate during stockpiling and test according to the Department's Manual of Field Testing and Sampling Practices.

The Department will reject aggregate when excessive variation of gradation or physical properties cause unworkable mixtures, mixture control problems, or non-conformance to the finished product or mixture requirements.

Coarse aggregates are subject to preliminary source approval.

**805.03 GENERAL REQUIREMENTS.** Provide coarse aggregates that are free of objectionable amounts of clay lumps, dirt coatings, and foreign material. The Department will reject contaminated aggregate when the Engineer deems it could be detrimental to the finished product.

**805.03.01 Soundness and Shale.** Conform to the following:

AGGREGATE USE	SHALE PERMITTED <sup>(1)</sup> (Maximum %)	SOUNDNESS REQUIREMENT (Maximum %)
<b><u>Portland Cement Concrete Mixtures</u></b>		
Class AA, Class S and Bridge Deck Overlays	1.0	9
All Other Concrete Classes and Uses	2.0	12
<b><u>Asphalt Mixtures</u></b>		
Aggregate for Polish Resistant Surfaces and Asphalt Surface Under OGFC:		
Limestone and Dolomite	1.0	9
Other Aggregate Types	2.0	12
All Other Asphalt Mixtures	2.0	15
<b><u>Other Uses</u></b>		
Sizes No. 610 or 710 When Used for Aggregate		
Surfacing, Traffic Bound Base, and Maintenance	5.0	18
Riprap and Channel Lining	2.0	12
All Other Uses	2.0	15

<sup>(1)</sup> The Department will determine shale quantity by visual estimation for Riprap and Channel Lining and according to KM 64-604 for all other aggregate.

**805.03.02 Physical Properties.** Conform to the following:

Wear (Except Slag and Sandstone)	40% (maximum)
Wear (Sandstone)	50% (maximum)
Wear (Slag)	60% (maximum)
Friable Particles	1.0% (maximum)
Unit Weight (Slag)	70 lbs/ft <sup>3</sup> (minimum)

**805.03.03 Gradation.** Where the Department specifies or permits designated sizes of coarse aggregates, provide aggregates meeting the grading limits indicated for the various sizes listed in the Sizes of Coarse Aggregates table. When the Contract does not specify sizes or combinations of aggregate for various types of construction, furnish aggregate according to the Aggregate Size Use table. The Department will allow blending of same source/same type aggregate to achieve designated sizes when precise procedures are used such as cold feeds, belts, or equivalent.

**805.04 CONCRETE.** Provide crushed stone or crushed or uncrushed gravel. The Department will allow any combination of crushed stone, crushed or uncrushed gravel when the combination is achieved in the concrete plant weigh hopper. Conform to the following:

	<u>Max. Pct. by Wt.</u>
Friable Particles	0.25
Finer than No. 200	2.0
Coal and Lignite	0.5
Lightweight particles (Gravel) <sup>(1)</sup>	4.0
(Sp. Gr. Less than 2.40)	
Lightweight particles (Limestone)	1.0
(Sp. Gr. Less than 2.40)	

<sup>(1)</sup> *The permissible lightweight particle content of gravel coarse aggregate for reinforced concrete box culvert sections, concrete pipe, pipe arches, or for use only in concrete that will be permanently protected from freezing by 2 feet or more of cover is 10.0 percent.*

The Department will waive the requirements for gradation and finer than No. 200 for precast reinforced concrete box culvert sections, concrete pipe, and pipe arches.

Do not use aggregate produced from an individual production lift until the Department obtains the finished product results from the Concrete Beam Expansion Test Method AASHTO T 160. If beam expansion is greater than 0.06 percent at 6 months, the Department will reject the production lift for use in concrete applications.

The Department will not require tests for Concrete Beam Expansion from an individual production lift if the individual ledges are accessible for hand sampling and the lift is acceptable based on petrographic examination of the hand samples. The Department will accept a production lift if no more than 20 percent of the total lift footage is considered potentially alkali carbonate reactive upon petrographic inspection.

**805.04.01 PCC Base, PCC Pavement, PCC Shoulders and Concrete for Bridge Decks.** The Department will subject coarse aggregates that are to be used in PCC base, PCC pavement, PCC shoulders, and bridge decks to freeze-thaw testing according to KM 64-626. The Department will allow sources having expansions of 0.06 percent or less to supply any size coarse aggregate listed in the Aggregate Size Use table, providing that size or a larger size has tested satisfactorily. When sources have expansions of more than 0.06 percent the Department will:

- 1) Reject the material.
- 2) Limit to the permitted sizes determined from acceptable freeze-thaw testing.

- 3) Allow the submittal of a proposal to the Engineer for production of acceptable coarse aggregate. The Department will require acceptable freeze-thaw test results before approving any proposal.

**805.04.02 Lightweight Aggregate.** When the Department allows lightweight aggregate conform to the following:

- 1) Dry Loose Unit Weight. As appropriate or as specified, AASHTO M 195, Table 2.
- 2) Gradation (by weight). Provide size specified, AASHTO M 195, Table 1.
- 3) Finer than No. 200. 3.0 percent maximum.
- 4) Wear. 50 percent maximum.
- 5) Soundness. 9 percent loss maximum.
- 6) Friable Particles. 1.0 percent maximum.
- 7) Deleterious Particles. 1.0 percent maximum.
- 8) Freeze-Thaw Resistance. 85 percent minimum durability factor and 0.06 percent maximum length change according to KM 64-626.
- 9) Provide creep, shrinkage, and tensile splitting strength test data made on concrete produced from the lightweight aggregate when the Engineer requests.
- 10) If lightweight aggregate from an unapproved source is proposed for use, notify the Engineer of the aggregate source and proposed concrete mix design at least 10 weeks before any lightweight aggregate concrete is placed, so the Department may subject the lightweight aggregate to testing as outlined above, plus any additional testing as deemed necessary and indicated in AASHTO M 195. At the Departments option, suitable documentation of such testing by an independent testing laboratory may be accepted.

**805.05 ASPHALT MIXTURES AND SEALS.** Provide crushed stone, crushed gravel, or blast furnace slag. The Department will allow any combination of crushed stone, crushed gravel, or blast furnace slag when the combination is achieved using cold feeds at the asphalt plant. The Engineer may allow other coarse aggregates.

**805.05.01 Absorption.** Provide aggregates having a water absorption of no more than 3.0 percent for each size and type. When blast furnace slag is used, provide total combined aggregates having a water absorption of no more than 4.0 percent.

**805.05.02 Crushed Particles.** Applies to the total combined aggregates retained on a No. 4 sieve, including the material from the fine aggregate. Conform to the following:

- A) **Superpave Mixtures.** Minimum percent crushed requirements as listed in the Superpave Coarse Aggregate Consensus Property Requirements table.
- B) **Open-Graded Friction Courses.** Minimum 95 percent one or more crushed faces and 75 percent 2 or more crushed faces.
- C) **Seal Coats.** Minimum 90 percent one or more crushed faces.
- D) **Other Mixtures.** Unless otherwise specified, minimum 75 percent one or more crushed faces.

SUPERPAVE COARSE AGGREGATE CONSENSUS PROPERTY REQUIREMENTS				
ESAL Class	Design ESALs (millions)	Coarse Aggregate Angularity (Percent), Minimum (Depth From Surface)		Flat and Elongated <sup>(d)</sup> (Percent), maximum
		≤ 100 mm	> 100 mm	
1	< 0.3	75/-	75/-	10
2	0.3 to < 3	75/-	75/-	10
3	3 to < 30	95/90	80/75	10
4	≥ 30	100/100	100/100	10

<sup>(d)</sup> Criterion based on a 5:1 maximum-to-minimum ratio.

**805.05.03 Flat and Elongated.** Provide aggregates for Superpave mixtures not exceeding the flat and elongated maximum as listed in the Superpave Coarse Aggregate Consensus Property Requirements table.

**805.05.04 Finer Than No. 200 (Seals).** Provide coarse aggregates having no more than 3.0 percent passing the No. 200 sieve.

**805.05.05 Polish-Resistant Aggregate.** Provide coarse aggregates required for polish-resistant applications from a Class A or Class B Polish-Resistant Aggregate Source, as applicable, based on mixture designation of aggregate type.

**805.06 DENSE GRADED AGGREGATE (DGA) AND CRUSHED STONE BASE (CSB).** Provide crushed stone having a sand equivalent value of 30 or greater with mineral filler as needed to meet gradation requirements. The Department may waive the sand equivalent requirement when the portion passing the No. 40 sieve has a plasticity index of 4 or less according to AASHTO T 90.

**805.07 FREE DRAINING BEDDING AND BACKFILL.** Provide crushed stone or crushed or uncrushed gravel. The Department will allow a shale content of 5 percent providing the combined shale, friable particles, and minus No. 200 content does not exceed 5 percent. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
1 1/2 inch	100
No. 4	0-30

**805.08 COARSE AGGREGATES FOR UNDERDRAINS.** Furnish crushed or uncrushed aggregate, including pea gravel meeting the quality requirements of Section 805 with the following exception: The Department will allow a shale content of 5 percent providing the combined shale, friable particles, and minus No. 200 content does not exceed 5 percent. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
1/2	100
No. 4	0-30
No. 100	0-5

**805.09 COARSE AGGREGATE FOR ROCK DRAINAGE BLANKET.** Provide crushed or uncrushed aggregate, including pea gravel, meeting the quality requirements of

this section with the following additional requirement: Ensure the minus No. 200 content does not exceed 5 percent. When the material includes a significant amount of individual fragments greater than 1 1/2 inches, the Engineer may accept the minus No. 200 portion based on visual inspection. Conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
4 inch	100
No. 4	0-30

**805.10 GRANULAR EMBANKMENT.** Provide granular material up to 2 1/2-inch maximum size with a maximum shale content of 5 percent. Use either:

- 1) Engineer approved shot limestone or sandstone from roadway excavation.
- 2) Crushed stone, crushed or uncrushed gravel, or crushed or natural sand meeting general requirements of Section 804 and this section, with a minus No. 200 content not exceeding 10.0 percent.

**805.11 STRUCTURE GRANULAR BACKFILL.** Conform to Subsection 805.09.

**805.12 REINFORCED FILL MATERIAL.** Obtain the Engineer's approval for material quality before use. Ensure the material is reasonably free of shale or other deleterious material. Conform to the following:

- A) **Gradation.** The Engineer may accept the material by visual inspection when it includes a significant amount of individual fragments greater than 1 1/2 inches.

<u>Sieve Size</u>	<u>Percent Passing</u>
4 inch	100
No. 200	5

- B) **Resistivity.** Greater than 3,000 ohm-cm (Applicable only when granular fill has more than 50 percent passing the No. 4 sieve).

- C) **PH.** Between 5-10.

- D) **Chlorides.** Less than 200 parts per million.

- E) **Sulfates.** Less than 1,000 parts per million.

- F) **Angle of Internal Friction.** Greater than or equal to 34 degrees. When providing gap-graded materials, single-size aggregates, natural sand, uncrushed gravel, or blends including uncrushed gravel, furnish a test report showing the 34 degree minimum internal friction angle is met. Test according to AASHTO T 236 using a sample of the material compacted to 95 percent of AASHTO T 99 Methods C or D (with oversize correction as outlined in Note 7) at optimum moisture content. When such materials are approved, the Engineer will perform sampling and testing on the project as necessary to assure that the material furnished is closely similar to that approved. The Department will not normally require testing on other aggregate types.

- G) **Erodible or Unstable Material.** Treat as applicable. The Department considers Size No. 57 or larger aggregate, except crushed or uncrushed gravel, non erodible. The Department considers the following materials to be erodible or unstable:

- 1) Friable sandstone. The Engineer determines when sandstone is friable or non-friable.
- 2) Crushed or uncrushed gravel, any size.
- 3) Crushed coarse aggregate (other than gravel) smaller than Size No. 57.
- 4) Any material with 50 percent or more passing the No. 4 sieve.



### **805.13 SLOPE PROTECTION AND CHANNEL LINING.**

**805.13.01 Cyclopean Stone Riprap and Channel Lining Class III.** Provide material meeting the general requirements of Section 805. No less than 80 percent, by volume, of individual stones that range in size from 1/4 to 1 1/2 cubic feet. The Department will allow stones of smaller sizes for filling voids in the upper surface and dressing to the proper slope.

**805.13.02 Crushed Aggregate Slope Protection.** Furnish aggregate meeting the general requirements of Section 805. Conform to the following gradation (Coarse aggregate sizes No. 1 and No. 2 conform to this requirement):

<u>Sieve Size</u>	<u>Percent Passing</u>
4 inch	100
2 1/2 inch	25-100
1 1/2 inch	0-15

**805.13.03 Channel Lining, Class IA.** Provide limestone meeting the general requirements of this section. Use a crusher, grizzly, or sieve with openings to produce a grading that 100 percent passes the 5 inch sieve, no more than 20 percent of the finished product passes through square openings 1 1/2 by 1 1/2 inches.

**805.13.04 Channel Lining, Class II.** Provide limestone meeting the general requirements of this section. Use a crusher, grizzly, or sieve with openings to produce a grading that 100 percent passes the 9 inch sieve, and no more than 20 percent of the finished product passes through square openings 5 by 5 inches.

**805.13.05 Channel Lining, Class IV.** Provide material excavated and prepared according to Section 204.

**805.13.06 Stone for Gabions.** Provide aggregate meeting the general requirements of this section and be of such gradation that 100 percent passes through a square opening of 12 by 12 inches and 100 percent is retained on a 4 inch sieve.

**805.14 AGGREGATE SURFACING, TRAFFIC-BOUND BASE, AND MAINTENANCE.** When providing size No. 610 or 710 coarse aggregate for aggregate surfacing (shoulders, entrances, mailbox turn outs, or similar items), traffic bound base and maintenance operations; furnish aggregate meeting the grading requirements in Sizes of Coarse Aggregates table, with no more than 12 percent finer than a No. 200 sieve.

When providing DGA for aggregate surfacing, traffic bound base, and maintenance operations conform to the grading requirement in Sizes of Coarse Aggregates table.

**805.15 GRADATION ACCEPTANCE OF NON-SPECIFICATION COARSE AGGREGATE.** It is intended that all aggregate purchased for Department work meet the requirements of this section. When reasonably acceptable work has been produced using the aggregate in question, the Department may accept the work according to Subsection 105.04. When the Engineer determines that the aggregate not conforming to gradation requirements may be left in place, the Department will accept the aggregate at a reduction in the Contract unit bid price for the work containing the aggregate according to the following procedures. The Department will not consider these procedures a means to continue accepting non-specification aggregates.

The Department will base the reduction on the invoice price for the aggregate at the source. When satisfactory invoices are not furnished, the Department will use current bin prices for that source on file with the Cabinet's Division of Purchases. The maximum deduction for non-specification material which is allowed to remain in place is 50 percent. When aggregate fails to conform to gradation on more than one sieve, the Department will

apply the largest payment reduction.

The Department will define a lot based on the smallest definable quantity of material represented by acceptance test results, either passing results or failing results, or both. Normally, the Department will average all test results for the lot to determine the test result for payment according to the deduction tables. However, when test results are not reasonably uniform the Department will not average the high and low test results within a lot. The Department will assign each test result to equal quantities in new smaller lots in proportion to the number of tests representing the original lot. When daily tests are performed, the lot will be a day's production unless the Department defines a smaller lot.

When 2 consecutive lots contain non-specification material, discontinue the use of the aggregate until the Department makes a decision concerning the overall acceptability of the aggregate from that source.

The Department will not impose a reduction in payment for quantities less than 50 tons unless the Engineer deems it necessary.

<b>GRADATION - SIZE NO. 1</b>					
Payment Reduction	Sieve Size-Percent Passing				
	4 inch	3 1/2 inch	2 1/2 inch	1 1/2 inch	3/4 inch
0%	100	90-100	25-60	0-15	0-5
10%			61-62		
10%	98-99	88-89	23-24	16-17	6-7
20%			22		
20%	97	87	63	18	8
30%			21		
30%	96	86	64	19	9
50%			20		
50%	95	85	65	20	10

<b>GRADATION - SIZE NO. 2</b>					
Payment Reduction	Sieve Size-Percent Passing				
	3 inch	2 1/2 inch	2 inch	1 1/2 inch	3/4 inch
0%	100	90-100	35-70	0-15	0-5
10%			33-34		
10%	98-99	88-89	71-72	16-17	6-7
20%			32		
20%	97	87	73	18	8
30%			31		
30%	96	86	74	19	9
50%			30		
50%	95	85	75	20	10

GRADATION - SIZE NO. 23				
Payment Reduction	Sieve Size-Percent Passing			
	3 inch	2 inch	1 inch	1/2 inch
0%	100	40-90	0-15	0-5
10%		38-39		
10%	98-99	91-92	16-17	6-7
20%		37		
20%	97	93	18	8
30%		36		
30%	96	94	19	9
50%		35		
50%	95	95	20	10

GRADATION - SIZE NO. 3					
Payment Reduction	Sieve Size-Percent Passing				
	2 1/2 inch	2 inch	1 1/2 inch	1 inch	1/2 inch
0%	100	90-100	35-70	0-15	0-5
10%			33-34		
10%	98-99	88-89	71-72	16-17	6-7
20%			32		
20%	97	87	73	18	8
30%			31		
30%	96	86	74	19	9
50%			30		
50%	95	85	75	20	10

GRADATION - SIZE NO. 357					
Payment Reduction	Sieve Size-Percent Passing				
	2 1/2 inch	2 inch	1 inch	1/2 inch	No. 4
0%	100	95-100	35-70	10-30	0-5
10%			33-34	8-9	
10%	98-99	93-94	71-72	31-32	6-7
20%			32	7	
20%	97	92	73	33	8
30%			31	6	
30%	96	91	74	34	9
50%			30	5	
50%	95	90	75	35	10

GRADATION - SIZE NO. 4					
Payment Reduction	Sieve Size-Percent Passing				
	2 inch	1 1/2 inch	1 inch	3/4 inch	3/8 inch
0%	100	90-100	20-55	0-15	0-5
10%			18-19		
10%	98-99	88-89	56-57	16-17	6-7
20%			17		
20%	97	87	58	18	8
30%			16		
30%	96	86	59	19	9
50%			15		
50%	95	85	60	20	10

GRADATION - SIZE NO. 467					
Payment Reduction	Sieve Size-Percent Passing				
	2 inch	1 1/2 inch	3/4 inch	3/8 inch	No. 4
0%	100	95-100	35-70	10-30	0-5
10%			33-34	8-9	
10%	98-99	93-94	71-72	31-32	6-7
20%			32	7	
20%	97	92	73	33	8
30%			31	6	
30%	96	91	74	34	9
50%			30	5	
50%	95	90	75	35	10

GRADATION - SIZE NO. 5					
Payment Reduction	Sieve Size-Percent Passing				
	1 1/2 inch	1 inch	3/4 inch	1/2 inch	3/8 inch
0%	100	90-100	20-55	0-10	0-5
10%			18-19		
10%	98-99	88-89	56-57	11-12	6-7
20%			17		
20%	97	87	58	13	8
30%			16		
30%	96	86	59	14	9
50%			15		
50%	95	85	60	15	10

GRADATION - SIZE NO. 57					
Payment Reduction	Sieve Size-Percent Passing				
	1 1/2 inch	1 inch	1/2 inch	No. 4	No. 8
0%	100	95-100	25-60	0-10	0-5
10%			23-24		
10%	98-99	93-94	61-62	11-12	6-7
20%			22		
20%	97	92	63	13	8
30%			21		
30%	96	91	64	14	9
50%			20		
50%	95	90	65	15	10

GRADATION - SIZE NO. 610				
Payment Reduction	Sieve Size-Percent Passing			
	1 1/2 inch	1 inch	1/2 inch	No. 4
0%	100	85-100	40-75	15-40
10%			38-39	13-14
10%	98-99	83-84	76-77	41-42
20%			37	12
20%	97	82	78	43
30%			36	11
30%	96	81	79	44
50%			35	10
50%	95	80	80	45

GRADATION - SIZE NO. 67					
Payment Reduction	Sieve Size-Percent Passing				
	1 inch	3/4 inch	3/8 inch	No. 4	No. 8
0%	100	90-100	20-55	0-10	0-5
10%			18-19		
10%	98-99	88-89	56-57	11-12	6-7
20%			17		
20%	97	87	58	13	8
30%			16		
30%	96	86	59	14	9
50%			15		
50%	95	85	60	15	10

GRADATION - SIZE NO. 68						
Payment Reduction	Sieve Size-Percent Passing					
	1 inch	3/4 inch	3/8 inch	No. 4	No. 8	No. 16
0%	100	90-100	30-65	5-25	0-10	0-5
10%			28-29	3-4		
10%	98-99	88-89	66-67	26-27	11-12	6-7
20%			27	2		
20%	97	87	68	28	13	8
30%			26	1		
30%	96	86	69	29	14	9
50%			25	0		
50%	95	85	70	30	15	10

GRADATION - SIZE NO. 710				
Payment Reduction	Sieve Size-Percent Passing			
	1 inch	3/4 inch	3/8 inch	No. 4
0%	100	80-100	30-75	0-30
10%			28-29	
10%	98-99	78-79	76-77	31-32
20%			27	
20%	97	77	78	33
30%			26	
30%	96	76	79	34
50%			25	
50%	95	75	80	35

GRADATION - SIZE NO. 78						
Payment Reduction	Sieve Size-Percent Passing					
	3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16
0%	100	90-100	40-75	5-25	0-10	0-5
10%			38-39	3-4		
10%	98-99	88-89	76-77	26-27	11-12	6-7
20%			37	2		
20%	97	87	78	28	13	8
30%			36	1		
30%	96	86	79	29	14	9
50%			35	0		
50%	95	85	80	30	15	10

GRADATION - SIZE NO. 8					
Payment Reduction	Sieve Size-Percent Passing				
	1/2 inch	3/8 inch	No. 4	No. 8	No. 16
0%	100	85-100	10-30	0-10	0-5
10%			8-9		
10%	98-99	83-84	31-32	11-12	6-7
20%			7		
20%	97	82	33	13	8
30%			6		
30%	96	81	34	14	9
50%			5		
50%	95	80	35	15	10

GRADATION - SIZE NO. 9-M				
Payment Reduction	Sieve Size-Percent Passing			
	1/2 inch	3/8 inch	No. 4	No. 8
0%	100	75-100	0-25	0-5
10%	98-99	73-74	26-27	6-7
20%	97	72	28	8
30%	96	71	29	9
50%	95	70	30	10

GRADATION - SIZE NO. 10			
Payment Reduction	Sieve Size-Percent Passing		
	3/8 inch	No. 4	No. 100
0%	100	85-100	10-30
10%			8-9
10%	98-99	83-84	31-32
20%			7
20%	97	82	33
30%			6
30%	96	81	34
50%			5
50%	95	80	35

GRADATION - SIZE NO. 11				
Payment Reduction	Sieve Size-Percent Passing			
	3/8 inch	No. 4	No. 8	No. 100
0%	100	40-90	10-40	0-5
10%		38-39	8-9	
10%	98-99	91-92	41-42	6-7
20%		37	7	
20%	97	93	43	8
30%		36	6	
30%	96	94	44	9
50%		35	5	
50%	95	95	45	10

GRADATION - DENSE GRADED AGGREGATE						
Payment Reduction	Sieve Size-Percent Passing					
	1 inch	3/4 inch	3/8 inch	No. 4	No. 30	No. 200
0%	100	70-100	50-80	30-65	10-40	4-13
5%		68-69	48-49	28-29		
5%	98-99		81-82	66-67	41-42	14
10%		66-67	46-47	26-27	9	
10%	96-97		83-84	68-69	43-44	15
20%	95	65	45	25		3
20%			85	70	45	16
30%		64	44	24	8	2
30%	94		86	71	46	17

GRADATION - CRUSHED STONE BASE							
Payment Reduction	Sieve Size-Percent Passing						
	2 1/2 inch	1 1/2 inch	3/4 inch	3/8 inch	No. 4	No. 30	No. 200
0%	100	90-100	60-95	30-70	15-55	5-20	0-8
5%		88-89	58-59	28-29	13-14	3-4	
5%	98-99		96-97	71-72	56-57	21-22	
10%		86-87	56-57	26-27	11-12	1-2	
10%	96-97		98	73	58	23	9
20%		84-85	54-55	24-25	9-10	0	
20%	95		99	74	59	24	10
30%		83	53	23	8		
30%	94		100	75	60	25	11



<b>GRADATION - FREE DRAINING BEDDING AND BACKFILL</b>		
Payment Reduction	Sieve Size-Percent Passing	
	1 1/2 inch	No. 4
0%	100	0-30
10%	98-99	31-32
20%	97	33
30%	96	34
50%	95	35

<b>GRADATION - COARSE AGGREGATES FOR UNDERDRAINS</b>			
Payment Reduction	Sieve Size-Percent Passing		
	1 1/2 inch	No. 4	No. 200
0%	100	0-30	0-5
10%	98-99	31-32	6
20%	97	33	7
30%	96	34	8
50%	95	35	9

<b>GRADATION - COARSE AGGREGATE FOR ROCK DRAINAGE BLANKET</b>		
Payment Reduction	Sieve Size-Percent Passing	
	4 inch	No. 4
0%	100	0-30
10%	98-99	31-32
20%	97	33
30%	96	34
50%	95	35

<b>GRADATION - CRUSHED AGGREGATE SLOPE PROTECTION</b>			
Payment Reduction	Sieve Size-Percent Passing		
	4 inch	2 1/2 inch	1 1/2 inch
0%	100	25-100	0-15
10%	98-99	23-24	16-17
20%	97	22	18
30%	96	21	19
50%	95	20	20

SIZES OF COARSE AGGREGATES																	
	Sieve	AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS) PERCENTAGE BY WEIGHT															
Size	Size (mm)	4 inch	3 1/2 inch	3 inch	2 1/2 inch	2 inch	1 1/2 inch	1 inch	3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 100	No. 200
1	3 1/2 inch	100	90-100		25-60		0-15		0-5								
2	2 1/2 inch			100	90-100	35-70	0-15		0-5								
23	2 1/2 inch			100		40-90		0-15		0-5							
3	2 inch				100	90-100	35-70	0-15		0-5							
357	2 inch				100	95-100		35-70		10-30		0-5					
4	1 1/2 inch					100	90-100	20-55	0-15		0-5						
467	1 1/2 inch					100	95-100		35-70		10-30	0-5					
5	1 inch						100	90-100	20-55	0-10	0-5						
57	1 inch						100	95-100		25-60		0-10	0-5				
610	1 inch						100	85-100		40-75		15-40					
67	3/4 inch							100	90-100		20-55	0-10	0-5				
68	3/4 inch							100	90-100		30-65	5-25	0-10	0-5			
710	3/4 inch							100	80-100		30-75	0-30					
78	1/2 inch								100	90-100	40-75	5-25	0-10	0-5			
8	3/8 inch									100	85-100	10-30	0-10	0-5			
9-M	3/8 inch									100	75-100	0-25	0-5				
10 <sup>(2)</sup>	No. 4										100	85-100				10-30	
11 <sup>(2)</sup>	No. 4										100	40-90	10-40			0-5	
DENSE GRADED AGGREGATE <sup>(1)</sup>	3/4 inch							100	70-100		50-80	30-65			10-40		4-13
CRUSHED STONE BASE <sup>(1)</sup>	2 inch				100		90-100		60-95		30-70	15-55			5-20		0-8

<sup>(1)</sup> Gradation performed by wet sieve KM 64-420

<sup>(2)</sup> Sizes shown for convenience and are not to be considered as coarse aggregates.

Note: The Department will allow blending of same source/same type aggregate when precise procedures are used such as cold feed, belt, or equivalent and combining of sizes or types of aggregate using the weigh hopper at concrete plants or controlled feed belts at the pugmill to obtain designated sizes.

AGGREGATE SIZE USE	
Type of Construction	Sizes to be Used
Asphalt Mixtures	See Subsection 403.03
Traffic-Bound Base	57, 610, 710, or DGA
PCC Base and Class P Concrete	57, 67, 68, 78, 8, or 9M with fine aggregate as specified in Section 804
Cement Concrete Structures and Incidental Construction	57, 67, 68, 78, 8, 9M for Classes “A”, “AA”, “D”, “D” Modified, “S”, and “B” (3&57, 4&67, 357, 467 also for Class B); 67, 68, 78, 8, 9M for Classes “M1”, “M2”, “AAA”, “A” Modified; with fine aggregate as specified in Section 804

**805.16 SAMPLING AND TESTING.** The Department will sample and test coarse aggregates at locations and frequencies that the Engineer determines. The Department will sample and test according to the following methods when applicable:

Absorption (Coarse Aggregate)	AASHTO T 85
Chlorides	Calif. DOT 422
Clay Lumps	AASHTO T 112
Coal and Lignite	KM 64-615
Concrete Beam Expansion Test	AASHTO T 160
Dry Sieve Analysis	AASHTO T 27
Finer Than No. 200	KM 64-606 or AASHTO T 11 (Procedure B)
Flat and Elongated Particles	ASTM D 4791
Freeze/Thaw	KM 64-626
Friable Particles	AASHTO T 112
Insoluble Residue	ASTM D 3042
Lightweight Particles	AASHTO T 113
Percent Crushed Particles	ASTM D 5821
pH	Calif. DOT 643
Plastic Limit and Plasticity Index	AASHTO T 90
Pore Index	KM 64-623
Resistivity	Calif. DOT 643
Sampling	AASHTO T 2
Sand Equivalent	AASHTO T 176
Shale	KM 64-604
Soundness (5 Cycles)	KM 64-610
Sulfates	Calif. DOT 417
Unit Weight	AASHTO T 19
Wear	AASHTO T 96
Wet Sieve Analysis	KM 64-620 or AASHTO T 27

## SECTION 806 — ASPHALT MATERIALS

**806.01 GENERAL.** Asphalt materials include performance-graded (PG) binders, emulsified asphalts, cut-back asphalts, and liquid asphalt for cold-patching mixtures. Provide asphalt materials of the specified grade conforming to the requirements specified in this section from suppliers listed in the Department's List of Approved Materials. Inclusion on the list of approved suppliers is obtained by following the guidelines of the Approved Supplier Certification (ASC) program contained in Kentucky Method (KM) 64-444. The guidelines of the Emulsified Asphalt Supplier Certification (EASC) program are contained in KM 64-445.

**806.02 ACCEPTANCE.** The Department will normally perform quality acceptance testing on samples obtained at the project site or Contractor's storage facility. When required by the Department, the asphalt supplier shall send, at his expense, representative samples of materials stored at the source terminal or refinery to the Department's Division of Materials.

When the Department accepts asphalt materials by pretesting and certification, the supplier shall provide 2 copies of the required certification of quality and compliance, contained on the supplier's bill-of-lading/load ticket, with each hauling unit for presentation to the Contractor and Department's representative at the point of delivery. Also, forward a copy of the bill-of-lading/load ticket directly to the Department's Division of Materials as soon as practical following shipments.

On the bill-of-lading/load ticket, include a statement of the quantity of materials within each load by weight and volume.

Do not use asphalt materials that are not properly covered by certification or otherwise tested and approved by the Department. When asphalt materials not of the specified grade, not appropriately certified, or not conforming to requirements when tested, become incorporated into projects, the Engineer will, according to Section 105, evaluate the work affected and require adjustment of pay quantities or corrective work as deemed appropriate.

**806.02.01 Acceptance of Non-Specification Asphalt Materials.** Furnish asphalt materials purchased for Department work conforming to the requirements of this section. The Department will apply the following procedures only when reasonably acceptable work has been produced using the material in question, as provided in Subsection 105.04. When use of non-specification material results in an inferior or unsatisfactory product, remove and replace the material at no expense to the Department, or at the Vendor's expense when materials are purchased directly by the Cabinet.

The Department may accept, at a reduced Contract price, asphalt materials not of the specified grade, not appropriately certified, or not conforming to specification requirements when check-tested, after an evaluation of the work. However, the Department will not consider these procedures a means to continue accepting non-specification material.

The Department will determine the price adjustment based on the delivered cost of the material.

When the material is not of the specified grade or not appropriately certified, the Department may deduct the full cost of the material.

When the material fails to conform to the specification requirements, the Department will normally make deductions according to the following schedules. As provided in Subsection 806.03, the Department has established field tolerances for determining the acceptability of failing material at no price deduction. The Department will determine the frequency of check-sampling and testing on pretested material. The Department will make deductions for failing test results based on the average of 2 check samples representing the material in question. When a sample fails on 2 or more tests, the Department may add the deductions, but the total deduction will not exceed 100 percent.

PG BINDER PRICE ADJUSTMENT SCHEDULE						
Test	Specification	100% Pay	90% Pay	80% Pay	70% Pay	50% Pay <sup>(1)</sup>
Original Binder						
Dynamic Shear, G*/* Test Temp. at 10 rad/s, °C	1.00 kPa Min.	1.00-0.95	0.94-0.90	0.89-0.85	0.84-0.80	< 0.80
RTFO Residue						
Mass Loss, %	1.00 Max.	1.01-1.10	1.11-1.20	1.21-1.30	1.31-1.40	> 1.40
Dynamic Shear, G*/* Test Temp. at 10 rad/s, °C	2.20 kPa Min.	2.20-2.00	1.99-1.70	1.69-1.50	1.49-1.30	< 1.30
PAV Aging						
Creep Stiffness						
S, Test Temp. at 60 s, °C	300 MPa Max.	300-315	316-330	331-345	346-360	> 360
m-value, Test Temp at 60 s, °C	0.300 Min.	0.300-0.285	0.284-0.280	0.279-0.275	0.274-0.270	< 0.270
Dynamic Shear, G*/* Test Temp. at 10 rad/s, °C	5,000 kPa Max.	5,000-5,500	5,501-5,800	5,801-5 900	5,901-6 000	> 6,000
Elastic Recovery, %	75 Min.	≥ 70	69-65	64-60	59-55	< 55

<sup>(1)</sup> If allowed to remain in place, the Department will review materials performing in this range on a project-by-project basis to determine if removal of the material is warranted.

POLYMER ASPHALT EMULSION PRICE ADJUSTMENT SCHEDULE							
Test	Grade	Specification	100% Pay	90% Pay	80% Pay	70% Pay	50% Pay <sup>(2)</sup>
Viscosity @ 122 °F, SFS <sup>(1)</sup>	RS-2P, CRS-2P, & HFMS-2P	60-400 <sup>(1)</sup>	55-480 <sup>(1)</sup>	50-54 <sup>(1)</sup>	45-49 <sup>(1)</sup>	40-44 <sup>(1)</sup>	≤ 39 <sup>(1)</sup>
Viscosity @ 122 °F, SFS	RS-2P, CRS-2P, & HFMS-2P	100-400	85-480	80-84 481-520	70-79 521-560	60-69 561-600	≤ 59 ≥ 601
Distillation: % Oil	RS-2P, CRS-2P, & HFMS-2P	0-3.0	0-5.0	5.5-8.0	8.5-10.0	10.5-12.0	≥ 12.5
% Residue	RS-2P, CRS-2P, & HFMS-2P	≥ 65	≥ 63	60.0-62.9	57.0-59.9	55.0-56.9	≤ 54.9
Sieve, %	RS-2P, CRS-2P, & HFMS-2P	≤ 0.1	≤ 0.35	0.36-0.50	0.51-0.70	0.71-0.90	≥ 0.91
Residue Penetration @ 77 °F	RS-2P, CRS-2P, & HFMS-2P			80-84	75-79	70-74	≤ 69
	RS-2P, CRS-2P, & HFMS-2P	100-200	85-230	231-240	241-250	251-260	≥ 261
Residue Ductility @ 77 °F, cm	RS-2P, CRS-2P, & HFMS-2P	≥ 50	≥ 45	40-44	35-39	30-34	≤ 29
Residue Ductility @ 39 °F, cm	RS-2P, CRS-2P, & HFMS-2P	≥ 15	≥ 13	11.0-12.9	9.0-10.9	7.0-8.9	≤ 6.9
Recovery @ 39 °F	RS-2P, CRS-2P, & HFMS-2P	≥ 55%	≥ 50%	45.0-49.9%	35.0-44.9%	25.0-34.9%	≤ 24.9%
Storage Stability	RS-2P, CRS-2P, & HFMS-2P	≤ 1.0	≤ 2.0	2.1-3.5	3.6-5.5	5.6-7.5	≥ 7.6
Demulsibility: 0.02N CaCl <sub>2</sub>	RS-2P	≥ 60%	≥ 53%	47-52%	41-46%	36-40%	≤ 35%
0.8% Sodium Dioctyl	HFMS-2P	≥ 30%	≥ 27%	24-26%	21-23%	18-20%	≤ 17%
Sulfosuccinate	CRS-2P	≥ 40%	≥ 35%	32-34%	29-31%	26-28%	≤ 25%
Float @ 140 °F, s	HFMS-2P	≥ 1200	≥ 1100	900-1099	700-899	500-699	≤ 499
Solubility, %	RS-2P, CRS-2P, & HFMS-2P	≥ 97.5	≥ 97.0	96.5-96.9	96.0-96.4	95.5-95.9	≤ 95.4
Softening Point of Residue, °F	RS-2P, CRS-2P, & HFMS-2P	> 100	> 97	95-97	91-94	88-90	≤ 87

<sup>(1)</sup> Applies only if the residue from distillation is 72% or more.

<sup>(2)</sup> If allowed to remain in place, the Department will review materials performing in this range on a project-by-project basis to determine if removal of the material is warranted.

EMULSIFIED ASPHALT PRICE ADJUSTMENT SCHEDULE							
Test	Grade	Specification	100% Pay	90% Pay	80% Pay	70% Pay	50% Pay <sup>(1)</sup>
Viscosity, Saybolt Furol @ 77 °F, s	CSS-1h, RS-1,			15-17	12-14	9-11	≤ 8
	SS-1, SS-1h	20-100	18-110	111-120	121-130	131-140	≥ 141
	AE-60, HFMS-2	≥ 100	≥ 90	80-89	70-79	60-69	≤ 59
	AE-200	≥ 50	≥ 45	40-44	35-39	30-34	≤ 29
@ 122 °F, s				40-44	35-39	30-34	≤ 29
	MS-3, MS-C3	50-500	45-550	551-555	556-560	561-565	≥ 566
	RS-2,			60-64	55-59	50-54	≤ 49
	HFRS-2	75-400	65-440	441-480	481-520	521-560	≥ 561
				85-89	80-84	75-79	≤ 74
	CRS-2	100-400	90-440	441-480	481-520	521-560	≥ 561
Residue by Distillation, %	SS-1, SS-1h,						
	CSS-1h	≥ 57	≥ 56	53-55	50-52	47-49	≤ 46
	RS-1	≥ 55	≥ 54	51-53	48-50	45-47	≤ 44
	MS-3, MS-3C,						
	CRS-2, HFMS-2	≥ 65	≥ 64	61-63	58-60	55-57	≤ 54
	RS-2,						
	HFRS-2	≥ 63	≥ 62	59-61	56-58	53-55	≤ 52
	AE-60	≥ 68	≥ 67	64-66	61-63	58-60	≤ 57
	AE-200	≥ 60	≥ 59	56-58	53-55	50-52	≤ 49
Oil Distillates	CRS-2	0-5	0-6	7-10	11-14	15-18	≥ 19
	AE-60, AE-200	0-6	0-7	8-10	11-13	14-16	≥ 17
	MS-3, MS-3C	2-7	1.5-8.0	1.2-1.4 8.1-10.0	0.9-1.1 10.1-12.0	0.5-0.8 12.1-14.0	≤ 0.4 ≥ 14.1
Demulsibility, %	RS-1, RS-2,						
	HFRS-2	≥ 60	≥ 57	51-56	45-50	39-44	≤ 38
	CRS-2	≥ 40	≥ 38	34-37	30-33	26-29	≤ 25
Residue Penetration	SS-1h,			34-36	31-33	28-30	≤ 27
	CSS-1h	40-100	37-108	109-120	121-130	131-140	≥ 141
	SS-1, RS-1,			87-91	82-86	77-81	≤ 76
	RS-2, HFRS-2,						
	HFMS-2	100-200	92-216	217-225	226-235	236-245	≥ 246
				87-91	82-86	77-81	≤ 76
	CRS-2	100-250	92-270	271-275	276-280	281-285	≥ 286
			37-39	34-36	31-33	28-30	≤ 27
	AE-60	40-90	37-97	98-110	111-120	121-130	≥ 131

<sup>(1)</sup> If allowed to remain in place, the Department will review materials performing in this range on a project-by-project basis to determine if removal of the material is warranted.

EMULSIFIED ASPHALT PRICE ADJUSTMENT SCHEDULE (CONTINUED)							
Test	Grade	Specification	100% Pay	90% Pay	80% Pay	70% Pay	50% Pay <sup>(1)</sup>
Cement Mixing	SS-1, SS-1h, CSS-1h	2.0 Max.	≤ 2.2	2.3-4.0	4.1-6.0	6.1-8.0	≥ 8.1
Particle Charge	CSS-1h, CRS-2, MS-3C	Positive	Not Applicable - Determines Only That Emulsion is Cationic				
Float Test @ 140 °F, s	MS-3, MS-3C	20-120	18-130	16-17 131-140	14-15 141-150	12-13 151-160	≤ 11 ≥ 161
	AE-200, HFRS-2, HFMS-2	≥ 1,200	≥ 1,100	800-1099	500-799	300-499	≤ 299
Coating Test, %	MS-3C, MS-3, AE-200, HFMS-2	≥ 95	≥ 90	85-89	80-84	75-79	≤ 74
Storage Stability	SS-1, SS-1h, CSS-1h, RS-1 RS-2, RS-2C, MS-3, HFRS-2 MS-3C, AE-60, AE-200	≤ 1.5	≤ 2.0	2.1-3.5	3.6-5.5	5.6-7.5	≥ 7.6
Solubility in Trichloroethylene, %	SS-1, SS-1h, CSS-1h RS-1, RS-2, CRS-2, MS-3, HFRS-2 MS-3C, AE-60, AE-200	≥ 97.5	≥ 97.4	97.1-97.3	96.8-97.0	96.5-96.7	≤ 96.4
Sieve, %	MS-3C, MS-3, RS-1, RS-2, HFRS-2 CRS-2, CSS-1h, SS-1h SS-1	≤ 0.10	≤ 0.30	0.31-0.45	0.46-0.60	0.61-0.75	≥ 0.76
Ductility @ 77 °F	SS-1, SS-1h, CSS-1h RS-2, CRS-2, RS-1, HFRS-2, HFMS-2	≥ 40	≥ 38	35-37	32-34	29-31	≤ 28
pH	MS-3	≥ 7.0	Not Applicable - Determines Only That Emulsion is Anionic				

<sup>(1)</sup> If allowed to remain in place, the Department will review materials performing in this range on a project-by-project basis to determine if removal of the material is warranted.



CUTBACK ASPHALT EMULSION PRICE ADJUSTMENT SCHEDULE						
PRIMER L						
Test	Specification	100% Pay	90% Pay	80% Pay	70% Pay	50% Pay <sup>(1)</sup>
Viscosity, Saybolt Furol, 77 °F	30-100	27-110	21-26	16-20	11-15	≤ 10
			111-120	121-130	131-140	≥ 141
Water Content	3-8	2.0-9	1.5-1.9	1-1.4	0.5-0.9	≤ 0.4
			10-11	12-13	14-15	≥ 16
Asphalt Content	≥ 45	≥ 44	40-43	36-39	32-35	≤ 31
Coating	100%	100%	95%	90%	85%	≤ 80%
Residue Test, Float @ 122 °F, s	≥ 80	≥ 75	70-74	60-69	50-59	≤ 49
Solubility in Trichloroethylene	≥ 97.5	≥ 97.4	97.1-97.3	96.8-97.0	96.5-96.7	≤ 96.4

<sup>(1)</sup> If allowed to remain in place, the Department will review materials performing in this range on a project-by-project basis to determine if removal of the material is warranted.

**806.03 FIELD TOLERANCES.** The Department will allow field tolerances for asphalt materials, sampled subsequent to delivery for either approval or check-testing, outside the specified property limits according to the Department's established criteria.

**806.04 TIME LIMITATION ON APPROVALS.** The Department will retest materials in storage at the terminal as deemed necessary. Additionally, the Department will retest for approval to use materials delivered, but not incorporated into the work, within one month (2 months for PG binders) from date of shipment. Request resampling and retesting for approval.

**806.05 SAMPLING.** The Department will sample all asphalt materials according to KM 64-404.

**806.06 PG BINDERS.** The Department will accept PG binders prepared by the refining of petroleum in the following grades:

- PG 58-22
- PG 64-22
- PG 70-22
- PG 76-22

For specialized applications, the Department may specify other binders. The Department's Division of Materials may approve binders not conforming to the above grades on an experimental basis.

**806.06.01 Modification.** Use only organic, non-particulate modifiers. All binders are to be homogeneous blends. Include a statement of the type of modification and refining process with all samples submitted to the Division of Materials for testing and certification.

Do not use plant-site or in-line blending.

Circulate or agitate the modified asphalt binders in the storage tank as specified in the Supplier's handling procedures. Obtain the Engineer's approval for the means of circulation.

**806.06.02 Requirements.** Submit written instructions to the Division of Materials for handling requirements. Submit the Supplier's written instructions and requirements for the proper use and handling of the asphalt binder to the Engineer. Include tank requirements, construction equipment requirements, and storage and mixing temperature requirements. Submit material test data and a certification of conformance prior to shipping material.

- 1) Provide binders with a minimum solubility of 99.0 percent when tested according to AASHTO T 44.
- 2) The Department will accept PG binders according to AASHTO MP 1.
- 3) Provide PG 76-22 binders that have a minimum elastic recovery of 75% when tested on material aged in accordance with AASHTO T 240 and tested in accordance with KM 64-440.

**806.07 EMULSIFIED ASPHALTS.** This subsection covers emulsified asphalts of the following grades:

- |          |          |          |         |
|----------|----------|----------|---------|
| • RS-1   | • RS-2   | • SS-1   | • SS-1h |
| • CSS-1  | • CSS-1h | • CRS-1  | • AE-60 |
| • AE-200 | • MS-3   | • HFRS-2 | • CRS-2 |
| • HFMS-2 | • MS-3C  |          |         |

**806.07.01 General Requirements.** Furnish emulsified asphalts that are homogeneous, showing no separation of asphalt during normal handling or storage. The Engineer will reject emulsified asphalt which has been frozen.

**806.07.02 Specific Requirements for Grades RS-1, RS-2, SS-1, HFRS-2, HFMS-2, and SS-1h.** Conform to AASHTO M 140 with the following exceptions:

- 1) The cement-mixing test is not required.
- 2) The penetration of grade SS-1h residue is not to exceed 100.
- 3) The storage stability of emulsions is not to exceed 1.5 percent.

**806.07.03 Testing of Grades RS-1, RS-2, SS-1, HFRS-2, HFMS-2, and SS-1h.** Perform tests according to AASHTO T 59. Use Tyrone Formation Limestone as the reference aggregate for the coating test.

**806.07.04 Specific Requirements for Grades CSS-1, CSS-1h, and CRS-1.** Conform to AASHTO M 208 (cationic emulsions) with the following exceptions:

- 1) The cement-mixing test is not required.
- 2) The penetration of grade CSS-1h residue is not to exceed 100.
- 3) The storage stability of emulsions is not to exceed 1.5 percent.

**806.07.05 Testing of Grades CSS-1, CSS-1h, and CRS-1.** Perform tests according to the methods referenced by AASHTO M 208, with the exception of performing the particle charge test as specified in Note 3 of the Emulsified Asphalt Requirements table. Use gravel aggregate as the reference aggregate for the coating test.

**806.07.06 Specific Requirements for Grades AE-60, AE-200, MS-3, CRS-2, and MS-3C.** Conform to the Emulsified Asphalt Requirements table.

**806.07.07 Testing of Grades AE-60, AE-200, MS-3, CRS-2, and MS-3C.** Perform tests according to AASHTO T 59 except as otherwise provided.

EMULSIFIED ASPHALT REQUIREMENTS					
Test	AE-60	AE-200	MS-3	CRS-2	MS-3C
Viscosity, Saybolt-Furol, at 77 °F, no less than s at 122 °F, s	100 -	50 -	- 50-500	- 100-400	- 50-500
Residue by Distillation, % min.	68	60	65	65	65
Sieve Test, retained on 850-µm (No. 20) mesh, % max.	-	-	0.10	0.40	0.10
Settlement, 5 days, % max. <sup>(1)</sup>	5.0	5.0	5.0	5.0	5.0
Storage Stability Test, one day, % max. <sup>(2)</sup>	1.5	1.5	1.5	1.5	1.5
Oil Distillate, %, by vol.	0-6	0-6	2-7	0-5	2-7
Particle Charge	-	-	-	Positive	Positive
pH (ASTM E70)	-	-	> 7.0	-	-
Coating Test, % coated, min. <sup>(3)</sup>	-	95	95	-	95
Demulsibility, 35 ml. 0.8 pct., Sodium Dioctyl Sulfosuccinate, % min.	-	-	-	40	-
Tests on Residue From Distillation: Penetration at 77 °F, 100 g, 5 s Float Test at 140 °F, s <sup>(4)</sup> Solubility in Trichloroethylene, % min. Ductility at 77 °F, % min.	40-90 - 97.5 -	- > 1200 97.5 -	- 20-120 97.5 -	100-250 - 97.5 -	- 20-120 97.5 40

- <sup>(1)</sup> The Department will waive the test requirement for settlement when the emulsified asphalt is used in less than 5 calendar days from the date of shipment.
- <sup>(2)</sup> The Department will allow the use of the 24-hour (one-day) storage stability test in place of the 5-day settlement test.
- <sup>(3)</sup> Coating Test for MS-3 and MS-3C. Perform according to AASHTO T59. Use Tyrone Formation limestone as the standard reference aggregate for MS-3 and crushed pit gravel from Carroll County, Kentucky, as the standard reference aggregate for MS-3C.
- <sup>(4)</sup> Float Test. Perform according to AASHTO T 50, except pour the residue into the float collar from the transfer container (usually an 8-ounce tin cup) while hot, immediately after completion of the distillation test. For AE-200 only, the minimum variation of 4 seconds for 2 determinations will not be required. Any sample passes this test when both determinations are more than 1,200 seconds.

**806.08 CUT-BACK ASPHALT EMULSION PRIMER (WATER-IMMISCIBLE TYPE).** Prepare Cut-Back Asphalt Emulsion Primer, designated herein as Primer L, by compounding a suitable solvent and water with a petroleum asphalt.

**806.08.01 Requirements.** Furnish Primer L that is of such consistency that it can be spread uniformly with a pressure distributor and that it will adhere to all types of aggregates or asphalt bases, even in the presence of water. Ensure that the material is capable of penetrating the existing surfaces so as to plug capillary voids, to coat and bond dust and loose mineral particles, and thus harden or toughen the surface and promote adhesion between it and the superimposed treatment or construction. In addition, ensure that Primer L complies with the following requirements:

<b>PRIMER L REQUIREMENTS</b>	
Viscosity, Saybolt-Furol (AASHTO T 59) at 77 °F, s	30-100
Water Content (AASHTO T 55 Using Xylen), %	3-8
Asphalt Content (AASHTO T 78 Using Residue From Water Content Determination and Results of Water Content Test), %	≥ 45
Tests on Residue From Distillation-Float Test (AASHTO T 50) at 122 °F, s	≥ 80
Wet Stone Coating Test (AASHTO T 59)	Pass
Solubility in Trichloroethylene (AASHTO T 44), %	≥ 97.5
Recommended Application Temperature, °F	60-120

**806.09 LIQUID (CUT-BACK) ASPHALTS.** This section covers liquid (cut-back) asphalts of the rapid-curing types, grades RC-70, RC-250, RC-800, and RC-3000, and medium-curing types, grades MC-30, MC-70, MC-250, MC-800, and MC-3000.

**806.09.01 Requirements.** For rapid-curing and medium-curing types, conform to AASHTO M 81 and M 82, respectively.

**806.09.02 Testing.** Perform tests according to the applicable methods referenced by AASHTO M 81 and M 82.

**806.10 POLYMER ASPHALT EMULSIONS.** These materials are designed to be used in seal coats and stress-absorbing membrane interlayers (SAMI).

Make the polymer modification to the base asphalt before the emulsification process.

Ensure that polymer-modified asphalt emulsions conform to the requirements in the following table.

POLYMER ASPHALT EMULSIONS						
Test on Emulsion (Test according to AASHTO T 59, except as noted)	CRS-2P		RS-2P		HFMS-2P	
	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity at 122 °F, SFS <sup>(1)</sup>	100	400	100	400	100	400
Storage Stability, 24-hr., % <sup>(2)</sup>	-	1	-	1	-	1
Sieve, 850-µm (No. 20 mesh, % retained)	-	0.1	-	0.1	-	0.1
Particle Charge	Positive	-	-	-	-	-
Demulsibility: 0.02 N CaCl <sub>2</sub> , %	-	-	60	-	30	-
0.8% Sodium Dioctyl Sulfosuccinate, %	40	-	-	-	-	-
Asphalt Res. From Distillation, % <sup>(1)(3)</sup>	65	-	65	-	65	-
Oil Distillate by Vol. of Emulsion, %	-	3.0	-	3.0	-	3.0
Test on Residue From Distillation %						
Penetration at 77 °F, 100 g, 5 s	100	200	100	200	100	200
Float at 140 °F, s	-	-	-	-	1200	-
Ductility at 77 °F, 5 cm/minute	50	-	50	-	50	-
Ductility at 39 ± 2 °F, 5 cm/minute	15	-	15	-	15	-
Recovery at 39 ± 2 °F, 1 hr, % <sup>(4)</sup>	55	-	55	-	55	-
Softening Point (AASHTO T 53), °F	100	-	100	-	100	-
Solubility in Trichloroethylene, %	97.5	-	97.5	-	97.5	-

<sup>(1)</sup> If the asphalt residue from distillation is at least 72%, the minimum viscosity at 122 °F may be reduced to 60 SFS.

<sup>(2)</sup> Provide a material that, after standing undisturbed for 24 hours, shows a uniform brown color throughout.

<sup>(3)</sup> Modify AASHTO T 59 to provide a maximum temperature of 400 ± 5 °F for at least 20 minutes.

<sup>(4)</sup> This method is a variation of AASHTO T 51. Prepare the specimens in the same manner, except condition the specimens and ductilometer at the test temperature of 39 ± 2 °F. Immediately after conditioning, place the specimen in the ductilometer and elongate it to 10 cm at the rate of 5 cm/min. Stop the ductilometer at 10 cm, and clip the specimen at the approximate mid-point of the elongated area with scissors or other suitable cutting device. Let the specimen remain undisturbed in the ductilometer at 39 ± 2 °F for one hour. After one hour, retract the specimen until the cut ends touch. At this point, note the ductilometer reading to the closest 0.5 cm. Calculate the percent recovery by the following formula:

$$\% \text{ Recovery} = \frac{10-A}{10} \times 100$$

A = Observed elongation in cm after rejoining of the specimen.

**806.11 ASPHALT COATING AND PAVING FOR METAL PIPE, PIPE ARCHES, AND ARCHES.** These requirements apply to all corrugated metal pipe, pipe arches, and arches that are required to be asphalt-coated or coated and paved, except pave field-assembled structural plate pipe and pipe arches as specified in Section 612.

**806.11.01 Asphalt Coating Material.** Furnish asphalt coating material conforming to AASHTO M 190 and, in addition, the following physical properties:

- 1) Penetration at 32 °F, ASTM D 5 or AASHTO T 49 - 20 minimum at 200 g for 60 seconds.
- 2) Penetration at 77 °F, ASTM D 5 or AASHTO T 49 - 35 to 55 at 100 g for 5 seconds.
- 3) Flash Point, ASTM D 92 or AASHTO T 48 - 450 °F minimum.
- 4) Specific Gravity, ASTM D 70 or AASHTO T 229 - 0.98 minimum.
- 5) Softening Point, ASTM D 36 or AASHTO T 53 - 200 °F minimum/230 °F maximum.

The Department will obtain random samples of the asphalt coating material for analysis. The Department will reject all material not conforming to AASHTO M 190 and this subsection.

**806.11.02 Application of Coating.** Ensure that the pipe or structural plate is clean and free of all dirt, grease, and water prior to coating. Lightly sandblast or chemically etch aluminum pipe before coating to provide a good surface profile.

Immerse the pipe or structural plate in asphalt material at  $400 \pm 5$  °F according to the following schedule:

Thickness ( <u>inch</u> )	Minimum Immersion Time ( <u>minutes</u> )
0.052	2.0
0.064	2.5
0.079	3.0
0.109	5.0
0.138	6.5
0.168	8.0

These immersion times apply when the temperatures of the metal before application is 41 °F or higher. When the metal temperature is below 41 °F, increase the immersion time as necessary to stabilize the metal temperature and produce a satisfactory coating properly bonded to the metal.

Dip the pipe or structural plate a second time for a sufficient time to obtain a minimum coating thickness of 0.050 inch.

**806.11.03 Application of Paving.** Pour asphalt material into the pipe invert with dams constructed at the ends in order to cover all corrugations and provide a smooth invert. Ensure that the asphalt depth above the crests of the corrugations is at least 0.125 inch. Ensure that the minimum asphalt temperature during the casting operations is 200 °F. Pave the required percentage of the circumference of the pipe according to AASHTO M 190.

**806.11.04 Acceptance of Coated Pipe or Structural Plates.** Ensure that each shipment of asphalt-coated metal pipe or structural plates is accompanied by a certification that all material furnished complies with the applicable specifications and that the asphalt coating was applied in accordance with this section.

The Department reserves the right to sample and test pipe, structural plates, or coating materials, or inspect coating procedures at the plant, at any time. The Department may reject material or coating not conforming to contract requirements whether it is in place or not.

**806.12 LIQUID ASPHALT FOR COLD-PATCHING MIXTURES.** Ensure that the liquid asphalt material furnished under this section provides satisfactory coating

properties, workability, and adherence characteristics for patching during cold and damp weather in either asphalt or concrete pavement surfaces. Furnish patching mixtures made with the liquid asphalt, KP-2 or KP-4, that is capable of being stored for at least 6 months before being used and that is readily workable at all ambient temperatures above 25 °F.

Provide with each shipment of material the certified test results showing that the materials furnished conform to the following KP-2 or KP-4 Requirements table. Additionally, take a one-gallon sample from one transport. Ship the sample to the Division of Materials by any expedient means of transport. Obtain the Division of Materials' approval before using the liquid asphalt.

<b>KP-2 REQUIREMENTS</b>		
Property	Test Method	Value
Flash Point	AASHTO T 79	200 °F minimum
Kinematic Viscosity at 140 °F	AASHTO T 201	300 – 4,000
Water	AASHTO T 55	0.2% maximum
Distillate Test: (volume of the original sample)	ASTM D 402	
to 437 °F		None
to 500 °F		0 - 5%
to 600 °F		0 - 25%
Residue From Distillate at 680 °F	ASTM D 402	72 - 95%
Residue Tests:		
Absolute Viscosity at 140 °F	ASTM D 2171	125 - 425
Penetration	ASTM D 5	200 minimum
Ductility at 39 °F at one cm/min.	ASTM D 113	100 minimum
Solubility in Trichloroethylene	ASTM D 2042	99% minimum
Stripping Test Uncoated	AASHTO T 182	5% maximum

<b>KP-4 REQUIREMENTS</b>		
Property	Test Method	Value
Flash Point	AASHTO T 79	200 °F minimum
Viscosity, Saybolt Furol at 122 °F, s	AASHTO T 72	100-500 <sup>(1)</sup>
Coating Test	AASHTO T 182	95.0% minimum
Residue From Distillate	AASHTO T 59	72.0% minimum
Oil Distillate	AASHTO T 59	3.0 - 7.0%
Penetration	ASTM D 5	200
Solubility in Trichloroethylene	ASTM D 2042	98% minimum

<sup>(1)</sup> The Department may accept higher values if the material is pumpable.

## SECTION 807 — JOINT MATERIALS

**807.01 DESCRIPTION.** This section covers joint sealers and joint fillers of various types. The Department may approve other types of joint materials provided they conform to the requirements of the type specified in the Contract.

### **807.02 JOINT SEALERS.**

**807.02.01 Hot-Poured, Elastic Joint Sealers.** Furnish hot-poured, elastic joint sealers that conform to ASTM D 3405. Ensure that the materials supplier furnishes, to the Department's Division of Materials, a sample of approximately 10 pounds of sealer for test purposes. Submit the sample at least 30 calendar days before the date of intended use.

**807.02.02 Preformed, Compression Joint Sealers With Lubricant Adhesive.** Furnish preformed, compression joint sealers of approved shapes and sizes for the applicable joints to be sealed.

Furnish sealers and lubricant adhesives that conform to the following applicable requirements and that are available for sampling at least 30 calendar days before the date of intended use.

- A) **Sealers.** Furnish sealers that conform to ASTM D 2628 with the following exceptions and additions:
- 1) The Department's Division of Materials and Division of Bridge Design will approve the shape or configuration of sealers. Provide sealers from the Department's List of Approved Materials. Obtain the Department's approval for sealers not on the List of Approved Materials before shipping to the project.
  - 2) Furnish sealers of a design and cross section that are substantially solid when fully compressed. The point at which a sealer is defined as being fully compressed is also defined as closure of the sealer. Provide closure of a sealer within a deflection range of 50 to 70 percent of the original width of the sealer.
  - 3) Ensure that the manufacturer provides sealers accurately marked at 12-inch intervals to determine elongation after installation.
  - 4) Ensure that sealers are designed so that, when compressed, the center portion of the top surfaces will not protrude upward above the original elevation of the sealer.
  - 5) The Department will subject sealers to a compression-deflection test in conformity with KM 64-409. Ensure that the sealer displays a minimum force per unit area of 3 psi at 15 percent deflection and a maximum force per unit area of 40 psi at 50 percent deflection.
  - 6) The Department will subject sealers to a compression-shear test in conformity with KM 64-410. Ensure that the sealers display a minimum resistive force of 0.5 pound per cubic inch to breaking away from the plates and a minimum resistive force of 1.0 pound per cubic inch to vertical displacement.
  - 7) Use sealers for the various joint widths of the sizes as follows:
    - a) Ensure that the sizes of sealers used in PCC pavement comply with the applicable Standard Drawing.
    - b) Ensure that the uncompressed depth of all sealers is at least equal to the uncompressed sealer width, unless the design of the sealer prevents twisting or misalignment of the sealer during or after installation.



- c) The listing of approved sealers includes products available for sealing the following joint sizes:

3/16"	1"	1 7/8"
1/4"	1 1/4"	2"
3/8"	1 1/2"	2 1/4"
1/2"	1 5/8"	2 1/2"
3/4"	1 3/4"	

- 8) Ensure that sealers are accompanied by a manufacturer's certification of test results covering each size and lot number.
- 9) Use sealers that have been tested and approved before use on each project. The Department will either pretest or test each size, configuration, and lot of sealers, from samples obtained after delivery to the project, according to the Manual of Field Sampling and Testing Practices. When the supplier delivers sealers to projects without pretesting, include at least 6 linear feet of additional sealer (not precut) for each size, configuration, and lot to allow for testing by the Department.

- B) Lubricant Adhesive.** Provide lubricant adhesive that is compatible with the sealer, concrete, and steel. Use a compatible lubricant adhesive recommended by the sealer manufacturer and conforming to ASTM D 2835.

#### 807.02.03 Joint Sealer for Rigid Pipe.

- A) Asphalt Mastic.** Furnish asphalt mastic joint sealing material of a smooth, uniform mixture of asphalt material, solvent, and filler. Use a filler that consists essentially of cellulose fiber. Ensure that the mixture is applicable, by means of a trowel or caulking gun, without pulling or drawing, and does not sag or flow when applied to metal, concrete, or vitrified clay surfaces.

Furnish compound capable of withstanding freezing and not exhibiting any tendency to separate or otherwise deteriorate while in storage.

When applied to a tinned panel or glass plate, in a layer 1/16 to 1/8-inch thick, and cured at room temperature for 24 hours, ensure that the compound sets to a tough, plastic coating and does not shrink, crack, or loosen from the surface.

In addition, furnish material conforming to the following table:

	<u>Minimum</u>	<u>Maximum</u>
Grease Cone Penetration (ASTM D 217, Unworked, 150 g, 77 °F, 5 s) 0.10 mm	175	250
Weight per gallon, lbs	9.75	-
Non-Volatile (10 g, 221 °F - 230 °F, 24 h), %	75	-
Ash (by Ignition), %	25	45

- B) Rubber Gaskets.** Furnish rubber gaskets conforming to the materials, manufacture, and physical requirements for gaskets in AASHTO M 198, Section 6.2.
- C) Flexible Plastic Gaskets.** Furnish flexible plastic gaskets conforming to the materials, manufacture and physical requirements for gaskets in AASHTO M 315, Section 6.1. Use only products from the Department's List of Approved Materials.

#### 807.02.04 Silicone Rubber Sealant.

- A) Non-Sag, Silicone Sealant.** Furnish the sealant in a one-part silicone formulation which does not require a primer for bonding to concrete. Use a

compound that is compatible with the surface to which it is applied. Do not use acid-cure sealants on concrete. Apply the sealant with a pressure applicator that forces it into the joint. Ensure that silicone rubber joint seals exhibit an adequate bond to concrete when subjected to testing by the Department.

Use non-sag silicone sealant conforming to the following table:

<b>SILICONE SEALANT REQUIREMENTS</b>		
Item	Requirement	Test Method
Flow	0.3 in. max.	KM 64-430
Extrusion Rate	75 - 350 g/minute	KM 64-430
Tack Free Time at 77 °F ± 3 °F	20 - 90 minutes	KM 64-430
Specific Gravity	1.010 - 1.515	ASTM D 792, Method A
Durometer Hardness, Shore A (7 Days Cured at 77 °F ± 3 °F and 45-55% Relative Humidity)	10-25	ASTM D 2240
Tensile Stress at 150% Elongation (7 Days Cured at 77 °F ± 3 °F and 45-55% Relative Humidity)	45 psi max.	ASTM D 412 (Die C)
Elongation (7 Days Cured at 77 °F ± 3 °F and 45-55% Relative Humidity)	600% min.	ASTM D 412 (Die C)
Ozone and UV Resistance	No chalking, cracking, or bond loss after 5,000 hours	ASTM D 793 and D 1149
Movement Capability and Adhesion	+100% and -50%; respectively; No adhesive or cohesive failure after 10 cycles at 0 °F	<sup>(1)</sup>
Shelf Life	6 months from date of shipment from the manufacturer	

<sup>(1)</sup> *Movement Capability and Adhesion: Prepare one by one by one-inch concrete blocks according to ASTM C 719. Use a sawed face for the bond surface. Seal 2 inches of the block leaving 1/2 inch on each end of the specimen unsealed. Ensure that the depth of sealant is 3/8 inch and the width is 1 inch. Subject the sealant to the movement according to ASTM C 719. Ensure that the magnitude of the movement is as specified, and the rate of extension or compression is 1/8 inch per hour.*

NON-SAG, SILICONE SEALANT PRICE ADJUSTMENT SCHEDULE						
Test	Specification	100% Pay	90% Pay	80% Pay	70% Pay	50% Pay <sup>(1)</sup>
Tack-Free Time at 77 °F ± 3 °F	20-90 minutes	15-95	12-14 96-98	9-11 99-101	6-8 102-104	≤ 5 ≥ 105
Specific Gravity	1.010-1.515	1.000-1.525	0.995-0.999 1.526-1.530	0.990-0.994 1.531-1.535	0.985-0.989 1.536-1.540	≤ 0.984 ≥ 1.541
Durometer Hardness, Shore A (7 Days Cured at 77 °F ± 3 °F and 45-55% Relative Humidity)	10-25	8-27	7 28	6 29	5 30	≤ 4 ≥ 31
Tensile Stress at 150% Elongation (7 Days Cured at 77 °F ± 3 °F and 45-55% Relative Humidity)	45 psi max.	46-50	51-53	54-56	57-59	≥ 60
Elongation (7 Days Cured at 77 °F ± 3 °F and 45-55% Relative Humidity)	600% min.	≥ 550	525-549	500-524	475-499	≤ 474

<sup>(1)</sup> If allowed to remain in place, the Department will review the materials performing in this range on a project-by-project basis to determine if removal of the material is warranted.

- B) Self-Leveling, Silicone Sealant.** Furnish the sealant in a one-part, cold-applied, self-leveling silicone formulation that cures to an ultra-low-modulus silicone rubber which remains flexible over a wide temperature range and is suitable for use in concrete to asphalt and concrete to concrete joints. This material is recommended for joints of one-inch width or less.

Use self-leveling, silicone sealant conforming to the following table:

<b>MATERIAL REQUIREMENTS FOR ONE-PART, SELF-LEVELING, SILICONE JOINT SEALANT</b>		
Test	Material Requirements as Supplied	Test Method
Appearance	Smooth, homogeneous, non-grainy mixture	CTM <sup>(1)</sup> 0176
Extrusion Rate (g/minute)	275 - 550	MIL-S-8802
Specific Gravity	1.26 - 1.34	ASTM D 792
Non-Volatile Content (% minimum)	96	CTM 0208
Skin-Over Time (minutes maximum)	60	CTM 0098
Upon Complete of Cure		
Joint Modulus <sup>(2)</sup> (psi maximum)	45	ASTM D 412
Elongation <sup>(2)</sup> (% minimum)	600	ASTM D 412 (Die C, Modified)
Adhesion: Asphalt-to-Concrete <sup>(2)</sup> (minimum % elongation)	600	ASTM D 3583 (Section 14, Modified)
Performance		
Movement (10 cycles at +100% and -50%)	No failure	ASTM C 719
Accelerated Weathering (5,000 hours)	No cracks, blisters, or bond loss	ASTM C 793

<sup>(1)</sup>In most cases, Corporate Test Methods (CTM) correspond to ASTM standard tests. Copies of CTM procedures are available upon request.

<sup>(2)</sup>Sample cured 21 days at 77 ± 3 °F and 50 ± 5 percent relative humidity.

SELF-LEVELING, SILICONE SEALANT PRICE ADJUSTMENT SCHEDULE						
Test	Specification	100% Pay	90% Pay	80% Pay	70% Pay	50% Pay <sup>(1)</sup>
Specific Gravity	1.26-1.34	1.22-1.38	1.20-1.21 1.39-1.40	1.18-1.19 1.41-1.42	1.16-1.17 1.43-1.44	≤ 1.15 ≥ 1.45
Skin-Over Time	60 minutes max.	61-65	66-68	69-71	72-74	≥ 75
Joint Modulus	45 psi max.	46-50	51-53	54-56	57-59	≥ 60
Elongation	600% min.	≥ 550	525-549	500-524	475-499	≤ 474

<sup>(1)</sup> If allowed to remain in place, the Department will review the materials performing in this range on a project-by-project basis to determine if removal of the material is warranted.

- C) **Rapid-Cure Silicone Sealant.** Use sealant that is furnished as a two-part, rapid-cure, cold-applied, ultra-low-modulus, self-leveling, 100 percent silicone rubber sealant which remains flexible over a wide temperature range and is suitable for use in concrete-to-concrete, concrete-to-steel, and steel-to-steel joints.

Use rapid-cure silicone sealant conforming to the following table:

As Supplied:

RAPID-CURE SILICONE JOINT SEALANT		
Test	Requirement	Test Method
Extrusion Rate (g/minute)	200 - 550	MIL S 8802
Specific Gravity	1.25 - 1.35	ASTM D 792
Non-Volatile Content (% minimum)	93	CTM 0208

As Installed: 77 °F and 50% Relative Humidity after 48 hours cure (does not pertain to skin-over time)

Test	Requirement	Test Method
Skin-Over Time (minutes maximum)	20	CTM 0098
Joint Elongation (% minimum)	600	ASTM D 412 <sup>(1)(2)</sup>
Joint Modulus, psi (at 100% elongation)	3-20	ASTM D 412 <sup>(1)(2)</sup>

<sup>(1)</sup> Pull rate of 2 inch/minute and joint size.

<sup>(2)</sup> Joint Size = 0.5 by 0.5 by 2 inches.

- D) **Accessory Items.** Use a closed-cell, polyethylene foam, back-up rod that is compatible with the sealant. Do not allow any bond or reaction to occur between the back-up rod and sealant.
- E) **Approvals.** A silicone sealant manufacturer shall have the product and the testing program evaluated before incorporating the sealant into a project. For qualified manufacturers, the Department may accept sealant for immediate use on the basis of manufacturer-certified test results indicating the material conforms to the requirements. Ensure that each lot of sealant is delivered in containers plainly marked with the manufacturer's name or trademark and a lot number. Ensure that the manufacturer furnishes certified test results of each lot of joint sealant shipped to each project (the Department does not require tests for ozone and UV resistance, or movement capability and adhesion, on every lot, but ensure that every lot is accompanied by certified results of the latest tests performed). Ensure that the manufacturer indicates the date of shipment on each lot. Do not use material after 6 months from the date of shipment from the manufacturer without first having the material sampled and tested. The Department will take routine check samples of silicone sealant during application and test it to verify the material's acceptability. Provide equipment suitable for obtaining representative check samples from the silicone sealant at a frequency determined by the Division of Material's Manual of Field Sampling and Testing Practices.

The Engineer may accept the foam back-up rod on the project by visual inspection.

### 807.03 JOINT FILLERS.

**807.03.01 General.** Furnish preformed fillers in a single piece for the full depth and

width required for the joint unless otherwise authorized. When the Engineer authorizes the use of more than one piece for a joint, fasten the abutting ends securely, and hold them accurately to shape.

**807.03.02 Preformed Sponge Rubber and Cork Expansion Joint Fillers.** Furnish preformed sponge rubber and cork joint fillers that conform to AASHTO M 153 for Type I (sponge rubber), Type II (cork), or Type III (self-expanding cork) as specified.

**807.03.03 Preformed Asphalt Expansion Joint Fillers.** Furnish preformed asphalt joint fillers that conform to AASHTO M 213.

**807.03.04 Oil Asphalt Joint Fillers.** Furnish oil asphalt joint fillers that conform to the following requirements:

- 1) Flash Point (AASHTO T 48) - 446 °F minimum;
- 2) Softening Point (AASHTO T 53) - 167 - 185 °F;
- 3) Penetration (AASHTO T 49):
  - at 77 °F, 100 g, 5 s - 30 – 45,
  - at 32 °F, 200 g, 60 s - 10 minimum,
  - at 115 °F, 50 g, 5 s - 90 maximum;
- 4) Loss on Heating (AASHTO T 47) - 1.0 percent, maximum;
- 5) Penetration (AASHTO T 49) at 77 °F, 100 g, 5 s, of residue from evaporation loss compared to original penetration before heating - 80 percent minimum;
- 6) Ductility (AASHTO T 51) at 77 °F - 30 mm minimum;
- 7) Matter Soluble in Trichloroethylene (AASHTO T 44) - 99.0 percent minimum; and
- 8) Ensure that the asphalt filler is free from water and does not foam when heated to the flash point.

## SECTION 808 — WATERPROOFING MATERIALS

**808.01 DESCRIPTION.** These specifications cover materials for use in waterproofing.

**808.02 ASPHALT PRIMER.** Conform to ASTM D 41.

**808.03 FIBERGLASS WATERPROOFING MEMBRANE.** Furnish a fiberglass waterproofing membrane that is a one-step waterproofing and reflective-crack suppression system for bridge decks. The one-step system is comprised of a high strength fiberglass reinforcement factory coating with an asphalt polymer and a strongly bonding contact adhesive on one side that bonds to the surface being treated.

Ensure that the fiberglass waterproofing membrane conforms to the following physical properties:

<u>Property</u>	<u>Test Method</u>	<u>Specification Value</u>
Tensile Strength	ASTM D 146	44 lbf/in (longitudinal and transverse)
Pliability	ASTM D 146	Pass at 32EF
Moisture	ASTM D 146	1% maximum
Permeability	ASTM E 96	10 Perms maximum



## **SECTION 809 — STRUCTURAL PLATES FOR PIPES, PIPE ARCHES, AND ARCHES**

### **809.01 CORRUGATED STEEL STRUCTURAL PLATE AND ACCESSORIES.**

Conform to AASHTO M 167. Coat with asphalt material conforming to Subsection 806.11. The Department will sample and test the material according to its current practices.

### **809.02 ALUMINUM ALLOY STRUCTURAL PLATE AND ACCESSORIES.**

Conform to AASHTO M 219. The Department will sample and test the material according to its current practices.

## SECTION 810 — PIPE AND PIPE ARCHES

**810.01 DESCRIPTION.** This section covers the various types of pipe and pipe arches for use on highway projects.

**810.02 APPROVAL.** Select pipe or pipe arches supplied by a producer that is listed on the List of Approved Materials. All producers of pipe and pipe arches must conform to KM 114. These requirements may be obtained from the Division of Materials.

### **810.03 REINFORCED CONCRETE PIPE.**

#### **810.03.01 Pipe Class.**

- A) **Circular.** Furnish circular reinforced concrete pipe conforming to AASHTO M 170 for Class I, Class II, Class III, Class IV, and Class V. Furnish a D-load pipe conforming to AASHTO M 242 when specified in the Contract.
- B) **Elliptical.** Furnish horizontal and vertical elliptical reinforced concrete pipe conforming to AASHTO M 207 for Class HE-A, Class HE-I, Class HE-II, Class HE-III, Class HE-IV, Class VE-V, Class VE-VI, Class V-II, Class VE-III, and Class VE-IV.
- C) **Arch.** Furnish reinforced concrete pipe arch conforming to AASHTO M 206 for Class A-II, Class A-III, and Class A-IV.

**810.03.02 Aggregates.** Conform to Section 804 and 805.

**810.03.03 Cement.** Use any type conforming to Section 801.

**810.03.04 Extra Protection.** Furnish concrete pipe with extra protection to inhibit corrosion when required by the Standard Drawings for culvert pipe, storm sewer pipe, and entrance pipe. Furnish concrete pipe with extra protection for all other types of pipe when specified in the Contract. Use reinforced concrete pipe conforming to Subsection 810.03.01 A) for Classes III, IV, and V; Subsection 810.03.01 B) for Classes HE-II, HE-III, HE-IV, VE-II, VE-III, and VE-IV; and Subsection 810.03.01 C) for Classes A-II, A-III, and A-IV. Use concrete having a minimum compressive strength of 6,000 psi at the time of acceptance. Use Wall B or Wall C as necessary.

When using one line of reinforcement, place it 1/2 of the shell thickness from the inner surface of the pipe. When using 2 lines of reinforcement, place each line so that the nominal protective covering of concrete is one inch from the outer surface of the pipe and 1 3/4 mm from the inner surface. The Department will allow a variation tolerance of  $\pm 1/2$  inch with a minimum protective covering of one inch from the inner surface in all cases.

**810.03.05 Identification and Markings.** Mark pipe sections according to AASHTO M 170 or M 207 as applicable for identification. Additionally, mark "EP" on each section of pipe manufactured by the extra protection requirements. When the manufacturer has more than one plant, include the plant letter assigned by the Division of Materials after the date of manufacture as follows:

L-Louisville

N-London

Provide shipment approval form containing the following information:

- 1) Project Number and county.
- 2) Name of Contractor.
- 3) The size, class, and quantity of pipe shipped.
- 4) The dates of manufacture of the pipe.
- 5) A signed statement that the pipe is from a tested and approved lot.

The Department will not require the certification on the shipment approval form to be notarized. The Department will not require the information under "Pipe Data" on the approval form when the manufacturer's shipment ticket is attached and contains the necessary information.

The Engineer will check pipe joints to determine if the information on the approval form or shipping ticket corresponds to the pipe actually received. Correct all discrepancies before using pipe.

**810.03.06 Defects.** The Department will reject pipe for any of the following reasons.

- 1) Exposed steel in walls, fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
- 2) Defects that indicate imperfect proportioning, mixing, or molding.
- 3) Surface defects indicating honey-combed or open texture.
- 4) Damaged or cracked ends that prevent a satisfactory joint.
- 5) A continuous crack, regardless of its position in the wall of the pipe, having a surface width of 0.01-inch or more and extending 12 inches or more.

#### **810.04 CORRUGATED METAL PIPE.**

**810.04.01 Coating Requirements.** Use asphalt coating and paving as extra protection to inhibit corrosion for the pH values shown on the Standard Drawings for culvert pipe, storm sewer pipe and entrance pipe. Coat and pave sanitary sewer pipe and all other pipe when specified in the Contract. Coat and pave the invert according to Subsection 806.11. Use asphalt material conforming to Subsection 806.11. Coat and pave the pipe according to AASHTO M 190.

Use polymer precoated galvanized corrugate metal pipe when the pH is greater than 9 or less than 5 according to the Standard Drawings. Manufacture according to AASHTO M 246, with a minimum grade of 10/10. Fabricate the sheets into pipe sections according to AASHTO M 36. Use asphalt material conforming to Subsection 806.11. Coat and pave the pipe according to AASHTO M 190.

The Department will allow exceptions for coating on storm sewer pipe and entrance pipe as specified in the Standard Drawings.

**810.04.02 Inlet and Outlet Requirements.** Finish all pipe ends in a neat manner to allow safe handling and contact with the pipe. Unless the pipe is asphalt coated, paint the ends with inorganic zinc primer. When using 14 gauge or thinner sheets to fabricate helical lockseam or welded seam pipe, reroll the inlet and outlet end with at least 2 complete corrugations.

**810.04.03 Pipe Type.** Furnish steel pipe conforming to AASHTO M 36 and aluminum alloy pipe conforming to AASHTO M 196 for types shown below:

- A) **Circular.** Type I or Type IR.
- B) **Arch.** Type II or Type IIR.
- C) **Underdrain.** Type III.

**810.04.04 Coupling Bands.** Furnish bands with annular or helical corrugation conforming to AASHTO M 36 and the requirements of 701.03.05.

**810.04.05 Slotted Drain Pipe.** Furnish pipe according to Subsection 810.04.03 A) with the addition of a grate assembly to provide openings in the top of the pipe as specified in the Plans. Apply asphalt coating after slotted drain pipe is fabricated. Provide material for slotted drain pipe from a supplier on the Department's List of Approved Materials. Furnish one of the following types of grate assemblies:

- A) **Type I.** The grate assembly is fabricated from structural steel, galvanized

according to AASHTO M 111 after fabrication, and forms a continuous drain slot when 2 or more joints of pipe are bounded together.

- B) **Type II.** The grate assembly is fabricated from 14 gauge steel, galvanized according to AASHTO M 218, and laterally supported by a minimum of one foot, measured laterally, of concrete on each side.

**810.04.06 Defects.** The Department will reject pipe for any of the following reasons.

- 1) Variation from centerline.
- 2) Elliptical shape in pipe intended to be round.
- 3) Dents or bends in the metal.
- 4) Lack of rigidity.
- 5) Low asphalt coating thickness on coated pipe.
- 6) Cracks or lack of coating adhesion on coated pipe.
- 7) Insufficient coating to provide a smooth level flow line on fully lined pipe and pipe with a paved invert.
- 8) Paved sections with less than 25 percent coverage of the pipe circumference.

#### **810.05 SMOOTH METAL PIPE.**

**810.05.01 Cast Iron Pressure Pipe.** Conform to ASTM A 377.

**810.05.02 Welded and Seamless Steel Pipe for Bridge Floor Drains.** Furnish 6-inch diameter round standard weight pipe conforming to ASTM A 53, ASTM A 500, or ASTM A 501 with a minimum wall thickness of 0.28 inches.

**810.05.03 Black and Hot-Dipped Galvanized Welded and Seamless Steel Pipe for Ordinary Uses.** Furnish pipe conforming to ASTM A 53 of the size and weight specified in the Contract. The Department will allow plain or threaded end finish.

**810.05.04 Aluminum Alloy Extruded Structural Pipe.** For pipe with internal connections, conform to ASTM B 221, Schedule 40, Alloy 6063-T52 for railing and ASTM B210, Schedule 40, Alloy 6063-T832 for posts.

For pipe with welded connections, conform to ASTM B221, Schedule 40, Alloy 6061-T6 or ASTM B210, Schedule 40, Alloy 6061-T6.

#### **810.06 Thermoplastic Pipe.**

##### **810.06.01 Polyvinyl Chloride (PVC) Pipe.**

- A) **Pipe Underdrain.** Furnish perforated pipe for underdrains conforming to AASHTO M 304. Ensure all fittings and pipe are made from the same base material. Submit a manufacturer's certification that the pipe conforms to AASHTO M 304 to the Division of Materials annually. Use integral bell and spigot type joints with elastomeric seal joints and smooth inner walls.
- B) **Culvert and Entrance Pipe.** Furnish pipe and pipe fittings conforming to AASHTO M 304. Manufacture from low filler PVC plastic having a minimum ASTM 1784 cell classification of 12454. Use pipe fittings furnished by the pipe manufacturer.
- C) **Sliplining Pipe (Rehabilitation).** Furnish pipe conforming to ASTM F949. Manufacture from low filler PVC plastic having a minimum ASTM 1784 cell classification of 12454. Use integral bell and spigot type joints with a STAB-JOINT bell coupler filling flush with the outer wall surface.

##### **810.06.02 Corrugated High Density Polyethylene (HDPE) Pipe.**

- A) **Pipe Underdrain.** Furnish perforated pipe for underdrains conforming to AASHTO M 252. Use only Type S for edge drain outlet pipe. Use caps, bands, and other fittings that are of the same material as the pipe. Submit a manufacturer's certification that the pipe conforms to AASHTO M 252 to the Division of Materials annually. Use a length that minimizes the number of joints in a run or line and facilitates shipment, handling, and installation. Use snap-in-place bands or a split band taped in place with polyethylene tape for pipe-to-pipe connections as the Engineer directs. Cap remote ends with a snap-in-place cap. Use non-perforated pipe when specified in the Contract or when the Engineer directs.
- B) **Culvert Pipe, Storm Sewer, and Entrance Pipe.** Furnish pipe and pipe fittings conforming to AASHTO M 294, Type S or D. Use pipe fittings furnished by the pipe manufacturer. Use pipe couplings conforming to AASHTO M 294 and that are Department approved. When corrugations are spiral, use match marks, specially cut ends, or other acceptable methods to facilitate alignment of the corrugations at connections. Provide a minimum gap between adjacent sections of pipe. Submit a manufacturer's certification that the pipe conforms to resin requirements of AASHTO M 294 to the Division of Materials annually. Provide certification from the manufacturer with each shipment that the pipe conforms to AASHTO M 294. Use only Department approved pipe. The Department will perform all sampling and testing deemed necessary, either at the plant or on the project.

## SECTION 811 — STEEL REINFORCEMENT

**811.01 CLASSIFICATION AND CONDITION.** This specification covers bars, welded steel wire fabrics, bar mats, steel wire, prestressing strands, and load transfer assemblies. Ensure that these materials, when incorporated into the work, are reasonably free from dirt, paint, oil, grease, loose-thick rust, or other foreign substance and, when deemed necessary, are cleaned to the satisfaction of the Engineer. The Department will not require cleaning when these materials exhibit tight, thin, or powdery rust.

Reject reinforcement rusted sufficiently to cause it to fail specified physical properties or prestressing strands displaying pits visible to the naked eye.

**811.02 BARS.** For all bar reinforcement use Grade 60 deformed bars except as indicated for the following items:

- A) **PCC Pavement Tie Bars, Paved Ditches, Steps, Flume Inlets, Integral Curb, Right-of-Way Markers, Transverse Bars for Bar Mats, Piles, Cribbing, Small Drainage Structures, Pipe Headwalls, or Manhole Tops.** Use Grade 40, 50, or 60 deformed bars.
- B) **Steel Piling Encasement and Spiral Reinforcement for Precast (non-prestressed) Piling.** Use Grade 40, 50 or 60 plain or deformed bars.
- C) **Spiral Reinforcement (excluding piles).** Use Grade 60 deformed or plain bars.

**811.02.01 Requirements.** Furnish bar reinforcement for bridges, cast-in-place culverts, and cast-in-place retaining walls that conform to ASTM A 615 (billet) or ASTM A 616 (rail). Do not weld rail steel bar reinforcement. The Engineer will accept rail steel bar reinforcement in straight lengths only. Do not use rail steel bar reinforcement where field bending is allowed or required.

Furnish bar reinforcement for other uses that conform to either ASTM A 615 (billet), ASTM A 616 (rail), or ASTM A 617 (axle).

**811.02.02 Testing and Acceptance.** Identify all shipments of steel reinforcement by the producer's heat or test identification numbers. Obtain bar reinforcement from manufacturers included on the Department's List of Approved Materials. To be included on this list, Fabricators shall conform to KM 64-101.

**811.03 HOOK BOLTS AND ANCHOR BOLTS.** Conform to the design and dimensions provided in the Standard Drawings. Furnish hook tie-bolts that, when assembled as a unit, are capable of sustaining an axial load of 14,000 pounds or greater.

**811.04 WELDED STEEL WIRE FABRIC (WWF).** Conform to AASHTO M 55.

**811.05 WELDED DEFORMED STEEL WIRE FABRIC.** Conform to AASHTO M 221.

**811.06 BAR MATS.** Conform to ASTM A 184 and fabricate by welding deformed Grade 60 billet bars.

**811.07 STEEL WIRE.** Conform to AASHTO M 32.

**811.08 PRESTRESSING STRANDS.** Ensure that Uncoated Seven-Wire Stress Relieved Strand for Prestressed Concrete conforms to AASHTO M 203, Grade 270 or low relaxation strand Grade 270 as specified.

**811.09 LOAD TRANSFER ASSEMBLIES (CONTRACTION AND EXPANSION).** The Department will approve the design of assemblies before delivery to the project. The Department will approve assemblies incorporating the typical features

depicted by the Standard Drawings. The Department will reject assemblies at any time that deviate from previously approved designs and manufacturing procedures. Shop fabricate all assemblies.

Where chair bars fit over ends of dowel bars, form them to obtain a snug fit over the end of the dowel bar not welded to the chair bar.

Control welding to prevent a significant reduction in the areas of the dowel bars or the wires. Modify the load-transfer assemblies furnished for slip form construction to allow for approximately 4 inches of clearance between the assemblies and the slip forms. Accomplish this by welding the outer leg of the chair at an angle of approximately 90 degrees with the upper and lower spacer bars.

**811.09.01 Chair, Spacer, Aligning Bars, and Upper Tie Bars.** Furnish steel for these items that conforms to AASHTO M 32.

**811.09.02 Dowel Bars.** Furnish dowel bars that are plain round bars conforming to ASTM A 615, A 616, or A 617 with respect to mechanical properties only. Provide either Grade 40, 50 or 60 steel. Saw cut the free ends of the dowels and ensure that they are free of burrs or projections. Coat dowel bars according to AASHTO M 254 with the following exceptions for Type B coatings:

- 1) ensure that the thickness is  $12 \pm 3$  mils,
- 2) subject the coated dowel bars to a bend test (KM 64-102),
- 3) use a bond breaker from the Department's List of Approved Materials for load transfer assemblies,
- 4) the maximum pull-out load shall not exceed 2,500 pounds,

Use any Type B Coatings that are on the Department's List of Approved Materials for epoxy coating materials, and apply them (except for thickness) according to Subsections 811.10.03 and 811.10.04.

The Department will inspect and accept dowel bars with Type B coatings as specified in Subsection 811.10.06. Obtain a Certificate of Compliance as specified in Subsection 811.10.07.

**811.09.03 Dowel Bar Sleeves.** Furnish a sleeve for each dowel bar used with expansion joints. Place these sleeves on alternate and opposite ends of the dowels. Furnish sleeves manufactured from sheet metal or metal tubing having a minimum thickness of .010 inch, 32 gage. Ensure that they are of such length as to cover no less than 2 inches nor more than 3 inches of the dowel, have a closed end, fit the dowel bar snugly, and are of such design as to provide an unobstructed expansion space of no less than one inch to allow movement of the dowel bar.

**811.09.04 Fabrication Tolerance.** Ensure that the longitudinal alignment of dowel bars in load transfer assemblies is within 1/4 inch in 18 inches of the specified alignment.

When checked along the total length of the dowels, allow the deviation to be  $0 \pm 1/4$  inch for assemblies on a zero degree skew, and  $3 \pm 1/4$  inch for assemblies on a 9.5 degree skew.

## **811.10 EPOXY COATED STEEL REINFORCEMENT.**

**811.10.01 Uncoated Bars.** Ensure that the deformed steel bars conform to the applicable requirements of Subsections 811.01 and 811.02. In addition, blast clean all surfaces of the steel bars to a near-white surface finish according to SSPC-SP 10. Blast clean to produce a surface having a profile no greater than 3 mils. Immediately before application of the coating, ensure that the blast cleaned surface corresponds with either pictorial standard A SP 10, B SP 10, or C SP 10 of SSPC-Vis 1, and the surfaces are free of all dust and grit.

**811.10.02 Epoxy Coating Material.** Select the epoxy coating material for reinforcing steel from the Department's List of Approved Materials. Ensure that the coating material conforms to the prequalification requirements of ASTM D 3963 Annex. Submit documentation in the form of test results from a private testing laboratory verifying that the coating material conforms to ASTM D 3963 to the Division of Materials to gain approved list status.

Select and furnish the powdered epoxy resin of the same material and quality as the resin which has been previously submitted for prequalification. Ensure that the resin manufacturer annually furnishes a written certification to the Division of Materials that attesting to the sameness of the powdered epoxy resin.

Obtain the approval of the Engineer for epoxy material for touch-up and repair work. Ensure that the epoxy material furnished by the epoxy manufacturer is compatible with the coating material and inert in concrete, and is suitable for use in the field.

**811.10.03 Application of Epoxy Coating Material.** Notify the Director of the Division of Materials at least 2 weeks before performing blast cleaning and applying of the epoxy coating, so the Department can inspect the work. Apply the powdered epoxy resin to the blast cleaned steel bars within 8 hours after blast cleaning and before any visible rusting of the near-white surfaces appears. Apply the resin as an electrostatically charged dry powder sprayed onto the grounded steel bars by electrostatic sprays. Ensure that the steel bars are at the temperature recommended by the powdered epoxy resin manufacturer at the time of the application of the coating.

After coating the bars, give them the thermal treatment recommended by the manufacturer of the powdered epoxy resin to provide fully cured coating on the bars. Touch up all uncoated areas of electrical contact points as directed.

Ensure that the epoxy coating applied to the bars is uniform and smooth with 90 percent of the film thickness measurements falling between 7 and 12 mils after curing, when checked according to KM 64-102.

The Department will reject the coated bars for either an insufficient or excessive film thickness or a partially cured coating.

**811.10.04 Properties of the Coated Bars.** Ensure that the coated bars, after curing, display a continuous, flexible, and abrasion resistant coating as determined by the following.

- A) **Continuity of Coating.** After curing, check all bars visually for defects in the coating such as holes, voids, delaminations, contamination, and damaged areas. In addition, check for "holidays" (pinholes not visually discernible) according to KM 64-102. When any bar has more than 2 defects or "holidays" per linear foot or a total defective area exceeding 0.25 percent of the surface area per linear foot, repair the defects or "holidays" with the touch-up material. When any bar has more than 5 defects or "holidays" per linear foot or a total defective area exceeding 0.5 percent of the surface area per linear foot, the Department will reject the bar.
- B) **Flexibility of Coating.** The Department will evaluate the flexibility of the coating by bending tests according to KM 64-102. Ensure that the coated bars are capable of being bent 120 degrees (after rebound) over a mandrel, without any visible evidence of cracking the coating.
- C) **Recleaning.** Do not remove the coating from rejected bars for the purpose of recoating by any process involving temperatures higher than 500 °F.
- D) **Color of Coating.** For all epoxy coatings use a light color that will provide a distinct contrast with the color of cleaned steel, and the color of rusted steel.

**811.10.05 Fabrication of Coated Bars.** Fabricate the steel bars into the shapes and lengths specified on the bridge plans either before or after coating. When performing fabrication after coating the bars, repair any damage to the coating. Repair the coating on straight portions of the bars when damaged or bare areas exceed 0.25 percent of the coated



area per linear foot or when individual damaged areas are in the order of 0.063 square inch, 1/4 inch by 1/4 inch or larger. When repairing coating, clean and repair all damaged and bare areas on the straight portion of the bar. When the amount of repair in the straight portion of a bar exceeds 2 percent of the surface area per linear foot the Department will reject the bar.

Repair coating within each bent area of the bar when bond loss and damage exceed 0.25 percent of the surface area within each bent area or when individual damaged areas are in the order of 0.063 square inch, 1/4 inch by 1/4 inch or larger. When repairing coating, clean and repair all damage within each bent area. When the amount of repair in a particular bent portion of a bar exceeds 2 percent of the surface area, the Department will reject the bar. It is not necessary to repair hairline cracks that do not have bond loss or other minor damage on fabrication bends.

Do not allow the amount of touch-up area for repair of defects and necessary overlap to exceed 5 percent of the surface area of the bar per meter for straight bars.

Do not allow the amount of touch-up area for repair of defects and necessary overlap to exceed 10 percent of the surface area of the bar per linear foot for bent portions of bars.

The Department will approve of all cleaning and repair methods and materials. Coat the ends of the coated bars cut during fabrication with the epoxy used for repairs. Repair the damaged areas and the coating of the ends of cut bars within 24 hours and before any visible rusting appears.

Obtain the Department's approval for any additional requested splices to accommodate lengths suitable for coating. Make requested additional splices at no additional expense to the Department.

Coat all areas receiving touch-up material, including ends with a minimum thickness of 5 mils. The Department will allow a maximum thickness of 16 mils in repair of overlap areas.

Extend touch-up material, applied to sheared or sawn bar ends to coat the resulting damaged area, up to a maximum of 7 inches from the end of the bar. When the sheared or sawn surface conforms to the specifications after touch-up, the Department will not count the bar end and first 7 inches from the bar end in determining the percent of repair area.

**811.10.06 Inspection and Acceptance.** Before subjecting them to blast cleaning and coating with the powdered epoxy resin, confirm that uncoated steel bars are from a manufacturer on the Department's List of Approved Materials for Reinforcing Steel Manufacturers. The Department may inspect and test all materials at the coating plant, and after delivery to the project.

Use an epoxy coater to apply the coating that is on the Department's List of Approved Materials. To be approved, epoxy coaters must conform to KM 64-101 and KM 64-102.

If the Department's inspection or testing indicates that material furnished to a Department project materially differs from the specification requirements, the Department will review and reconsider the approval of the epoxy coater's quality control program.

**811.10.07 Certificate of Compliance.** Ensure that each shipment of epoxy coated steel reinforcement is accompanied by a Certificate of Compliance prepared by the epoxy coater according to KM 64-101.

**811.11 ACCEPTANCE PROCEDURES FOR NON-SPECIFICATION REINFORCING STEEL.** Ensure that all reinforcing steel conforms to the requirements of this section. However, when non-specification reinforcing steel is inadvertently incorporated into the work before completion of testing, the Department may accept the material with a reduction in pay, provided the failure is marginal and will not cause poor performance. When the failure is excessive, then remove the reinforcing steel, and replace it unless the Engineer determines that the reinforcing steel can remain in place with a 100 percent reduction rate. The Department will apply the largest payment reduction when the material fails to meet more than one specification requirement. The Department will calculate the payment reduction on the invoice cost of the material delivered at the project site. The Department will reject reinforcing steel that fails and has not been incorporated into the work.

YIELD STRENGTH				
% of Requirement	97% - 100% or more	91% - 96%	86% - 90%	85% or less
Reduction Rate	0%	20%	50%	<sup>(1)</sup>

TENSILE STRENGTH				
% of Requirement	97% - 100% or more	91% - 96%	86% - 90%	85% or less
Reduction Rate	0%	20%	50%	<sup>(1)</sup>

ELONGATION				
% of Requirement	97% - 100% or more	91% - 96%	86% - 90%	85% or less
Reduction Rate	0%	20%	50%	<sup>(1)</sup>

WEIGHT PER FOOT				
% of Requirement	94% - 100% or more	89% - 93%	86% - 88%	85% or less
Reduction Rate	0%	20%	50%	<sup>(1)</sup>

EPOXY COATING THICKNESS			
Thickness (mils)	7 - 13	14 - 15	0 – 6 Over 16
Reduction Rate	0%	25%	<sup>(1)</sup>

<sup>(1)</sup> Remove and replace the reinforcing steel unless the Engineer determines that the steel can remain in place at a 100% reduction rate.

## SECTION 812 — STRUCTURAL STEELS

### 812.01 STRUCTURAL STEEL SHAPES, PLATES, BARS, AND FASTENERS.

Conform to Charpy V-notch toughness requirements for structural steel for load carrying members in bridges when specified in the Plans.

**812.01.01 Structural Steel, All Types.** Conform to AASHTO M 270 (ASTM A 709), Grades 36, 50 50W, 70W, HPS70W, 100 and 100W. When the supplementary requirement of this specification are specified, they exceed the requirements of M 183, M 223, M 222, ASTM A 852, and M 244.

- A) **Structural Steel.** Conform to AASHTO M 270 Grade 36, AASHTO M 183, ASTM A 709 Grade 36, or ASTM A 36.
- B) **High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality.** Conform to AASHTO M 270 Grade 50, AASHTO M 223 Grade 50, or ASTM A 709 Grade 50, or ASTM A 572.
- C) **High-Strength Low-Alloy Structural Steel with 345 MPa Minimum Yield Point to 4 Inches Thick.** Conform to AASHTO M 270 Grade 50W, AASHTO M 222, ASTM M 270 Grade 50W, or ASTM A 588.
- D) **Quenched and Tempered Low-Alloy Structural Steel Plate with 485 MPa Minimum Yield Strength to 4 Inches Thick.** Conform to AASHTO M 270 Grade 70W, ASTM A 709 Grade 70W, or ASTM A 852.
- E) **High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.** Conform to AASHTO M 270 Grade 100/100W, AASHTO M 244, ASTM A 709 Grade 100/100W, or ASTM A 514.
- F) **High-Strength Low-Alloy, Quenched and Tempered Structural Steel Plate.** Conform to ASTM A 709 Grade HPS70W.

**812.01.02 Hot-Rolled Carbon Steel Sheets and Strip of Structural Quality, Grade 33 (Corrugated Steel Plank for Bridge Floors).** Conform to ASTM A 570.

**812.01.03 Cold Rolled Carbon Steel Sheet of Structural Quality, Grade “D” (40 ksi) (Corrugated Steel Plank for Bridge Floors).** Conform to ASTM A 611.

**812.01.04 Steel Sheet Piling.** Conform to AASHTO M 202 (ASTM A 328).

**812.01.05 Frames and Grates (for Catch Basins, Inlets, Outlets, and Manholes).** Use steel in these items that conforms to the following properties:

Yield Strength	36 ksi. minimum
Tensile Strength	58 ksi minimum
Elongation in 2-inch specimen	21 percent minimum

The Department will accept steel for frames and grates according to the Manual of Field Sampling and Testing Practices.

## SECTION 813 — MISCELLANEOUS METALS

**813.01 PINS AND ROLLERS.** Use steel specified in the AASHTO Standard Specifications for Highway Bridges conforming to AASHTO M 169 (ASTM A 108) or AASHTO M 102 (ASTM A 668).

**813.02 STEEL CASTING.** Conform to AASHTO M 103, Grade 70-36 (ASTM A 27).

**813.03 EXPANDING STEEL MANHOLE RISERS.** Use an approved type that expands to fit tightly and rigidly within the existing frame.

**813.04 GRAY IRON CASTINGS.** Conform to AASHTO M 105, Class 30-B.

**813.05 MALLEABLE CASTINGS.** Conform to ASTM A 47. Use the grade specified.

**813.06 CASTINGS FOR RIGHT-OF-WAY MARKERS.** Provide aluminum alloy conforming to ASTM B 26, Alloy 319.1.

**813.07 LEAD PLATES.** Manufacture plates from lead conforming to ASTM B 29.

### **813.08 ALUMINUM.**

**813.08.01 Cast Aluminum Sand Castings.** Conform to ASTM B 26, Alloy 356.0-T6.

**813.08.02 Aluminum Alloy Permanent Mold Castings.** Conform to ASTM B 108.

**813.08.03 Aluminum Alloy Sheet and Plate.** Conform to ASTM B 209.

**813.08.04 Aluminum Alloy Extruded Bars, Rods, Shapes and Tubes.** Conform to ASTM B 221, Alloy 6061-T 6511 or Alloy 6063-T 6.

**813.08.05 Aluminum Alloy Rolled or Extruded Shapes.** Conform to ASTM B 308, Alloy 6061-T4 and T 6.

**813.08.06 Aluminum Alloy Seamless Pipe.** Conform to ASTM B 241, Alloy 6061-T 6 and 6063-T 6.

**813.08.07 Aluminum and Aluminum Alloy Bars, Rods, and Wire Bolts.** Conform to ASTM F 468, Alloy 2024-T 4. Give finished bolts a minimum anodic coating of 0.0002 inch.

**813.08.08 Aluminum Nuts.** Conform to ASTM F 467, Alloy 6061-T6 or 6062-T 9. Give finished nuts a minimum anodic coating of 0.0002 inch.

**813.08.09 Welding Rods.** Conform to AWS A5.10.

### **813.09 STEEL BOLTS, NUTS, AND WASHERS.**

**813.09.01 Carbon Steel Bolts and Nuts.** Conform to ASTM A 307. Nuts conform to AASHTO M 291.

**813.09.02 High-Strength Steel Bolts, Nuts, and Washers.** Mark all bolts, nuts, and washers according to the appropriate ASTM Specifications. If using galvanized bolts, nuts, or washers, measure the thickness of the zinc coating. Take measurements on the wrench flats or top of bolt head.

Submit mill test reports for all steel used in the manufacture of the bolts, nuts, or washers to the Department for approval. Include with the mill test reports the place where the material was melted and manufactured. The Department will take field samples for testing to verify compliance with this section.

Ship bolts, nuts, and washers (where required) from each rotational-capacity lot in the same container. If there is only one production lot number for each size of nut and washer, the Department will allow shipping of the nuts and washers in separate containers. Permanently mark each container with the rotational-capacity lot number to allow identification at any stage before installation. Supply the appropriate mill test report, manufacturer's certified test report, or distributor's certified test report to the Engineer before beginning installation.

For bolts, nuts, and washers, conform to the following dimensions:

<b>BOLT AND NUT DIMENSIONS <sup>(1)</sup></b>					
Nominal Bolt Size in D	Bolt Dimensions in			Nut Dimensions in	
	Heavy Hexagon Structural Bolts			Heavy Hexagon Nuts	
	Width Across Flats F	Height H	Thread Length T	Width Across Flats W	Height H
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	1 7/64
1 1/4	2	25/32	2	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32

<sup>(1)</sup>ANSI Standards B 18.2.1 and B 18.2.2 shall govern tolerance to these dimensions.

WASHER DIMENSIONS IN MILLIMETERS <sup>(1)</sup>							
Circular Washers					Square or Rectangular Beveled Washers for American Standard Beams and Channels		
Bolt Size	Nominal Outside Diameter <sup>(2)</sup>	Nominal Diameter of Hole	Thickness		Minimum Side Dimension	Mean Thickness	Slope or Taper in Thickness
			Min.	Max.			
1/2	1 1/16	17/32	0.097	0.177	1 3/4	5/16	1:6
5/8	1 5/16	21/32	0.122	0.177	1 3/4	5/16	1:6
3/4	1 15/32	13/16	0.122	0.177	1 3/4	5/16	1:6
7/8	1 3/4	15/16	0.136	0.177	1 3/4	5/16	1:6
1	2	1 1/16	0.136	0.177	1 3/4	5/16	1:6
1 1/8	2 1/4	1 1/4	0.136	0.177	2 1/4	5/16	1:6
1 1/4	2 1/2	1 3/8	0.136	0.177	2 1/4	5/16	1:6
1 3/8	2 3/4	1 1/2	0.136	0.177	2 1/4	5/16	1:6
1 1/2	3	1 5/8	0.136	0.177	2 1/4	5/16	1:6
1 3/4	3 3/8	1 7/8	0.178 <sup>(3)</sup>	0.28 <sup>(3)</sup>	—	—	—
2	3 3/4	2 1/8	0.178	0.28	—	—	—

<sup>(1)</sup>ANSI Standard B 18.22.1 Type A washer tolerances apply to the nominal dimensions for outside diameter and hole diameter.

<sup>(2)</sup>May be exceeded by 1/4 inch.

<sup>(3)</sup>3/16 inch nominal.

- A) **Bolts.** Conform to AASHTO M 164 (ASTM A 325). Do not use bolts conforming to AASHTO M 253 (ASTM A 490). Hardness for bolt diameters 1/2 to 1 inch inclusive are as noted below:

HARDNESS NUMBER				
Bolt Size (in)	Brinell		Rockwell C	
	Min.	Max.	Min.	Max.
1/2 - 1	248	311	24	33

Perform proof load testing according to ASTM F 606 Method 1 at the minimum frequency specified in ASTM A 325.

Perform wedge testing on full size bolts according to ASTM F 606 paragraph 3.5 at the minimum frequency specified in ASTM A 325. If bolts are to be galvanized, perform tests after galvanizing.

Plain bolts must be oily to touch when delivered and installed.

- B) **Nuts.** Conform to AASHTO M 292 (ASTM A 194) as applicable or AASHTO M 291. If nuts are to be galvanized (hot dip or mechanically galvanized), use heat treated Grade 2H, DH, or DH3.

For plain (ungalvanized) nuts, use Grades 2, C, D, or C3 with a minimum Rockwell hardness of 89 HRB (or Brinell Hardness 180 HB), or heat treated Grades 2H, DH, DH3.

For nuts that are to be galvanized, overlap the nuts the minimum amount required for proper assembly allowing the nut to assemble freely on the bolt in the coated condition. Overlap the nuts according to the mechanical requirements of AASHTO M 291 and the rotational-capacity test requirements of this section.

Lubricate galvanized nuts with a lubricant containing a dye that contrasts

with the color of the galvanizing.

Perform proof load testing according to ASTM F 606, paragraph 4.2 at the minimum frequency specified in AASHTO M 291 or AASHTO M 292 (ASTM A 194). If nuts are to be galvanized, perform tests after galvanizing, overtapping, and lubricating.

- C) **Washers.** Conform to AASHTO M 293. If supplying galvanized washers, perform hardness testing after galvanizing. Remove coating before taking hardness measurements.

- D) **Rotational-Capacity Test.** Perform rotational-capacity tests on all black or galvanized (after galvanizing) bolt, nut, and washer assemblies by the manufacturer or distributor before shipping. Perform additional rotational-capacity tests on each lot at job sit. Use washers as part of the test even though they may not be required as part of the installation procedure. Perform the following:

- 1) Except as modified herein, perform rotational-capacity testing according to AASHTO M 164.
- 2) Test each combination of bolt production lot, nut lot, and washer lot, shipped as a rotational-capacity lot, as an assembly. Where washers are not required by the installation procedures, the Department will not require lot identification for them.
- 3) Assign a rotational-capacity lot number to each combination of lots tested.
- 4) Test at least 2 assemblies per rotational-capacity lot.
- 5) Assemble the bolt, nut and washer assembly in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device (Note this requirement supersedes the ASTM A 325 requirement that the test be performed in a steel joint). For bolts too short to be assembled in the Skidmore-Wilhelm Calibrator, test them according to 9) below.
- 6) Provide the minimum rotation, from a snug tight condition (10 percent of the specified proof load), as follows:

300 degrees (0.83 turn) for bolt lengths  $\leq 4$  diameters  
360 degrees (1 turn) for bolt lengths  $> 4$  diameters and  $\leq 8$  diameters  
480 degrees (1.33 turns) for bolt lengths  $> 8$  diameters

- 7) Ensure that the tension reached at the above rotation is  $\geq 1.15$  times the required installation tension. The installation tension and the tension for the turn test are as noted below:

TENSION		
Diameter (inches)	Req. Installation Tension (kips)	Turn Test Tension (kips)
1/2	12	14
5/8	19	22
3/4	28	32
7/8	39	45
1	51	59
1 1/8	56	64
1 1/4	71	82
1 3/8	85	98
1 1/2	103	118

- 8) After exceeding the required installation tension listed above, take and

record one reading of tension and torque. Ensure that the torque value conforms to the following:

Torque  $\leq 0.25 PD$

Where: Torque = measured torque (foot-pounds)  
P = measured bolt tension (pounds)  
D = bolt diameter (feet)

- 9) Test bolts too short for assembly in a Skidmore-Wilhelm Calibrator in a steel joint. Disregard the tension requirement of 7) above. For the maximum torque requirement of 8) above, use a value of P equal to the turn test tension shown in the table in 7) above.

The Department will not require an inspection agency present during testing; however, the manufacturer or distributor performing the tests shall certify that the results recorded are accurate. The Engineer reserves the right to witness testing on request.

Ensure that the lot number appearing on the shipping package for bolts, washers, and nuts corresponds to the lot number identified on the distributor's and manufacturer's certification.

Provide the Engineer with the certified test report from the manufacturer or distributor performing the rotational-capacity test. Include the following information:

- a) The lot number of each of the items tested.
- b) The rotational-capacity lot number.
- c) A statement that the items conform to this section and the Contract.
- d) The results of the tests.
- e) The location and date of the tests.
- f) The location where the bolt assembly components were manufactured.

**813.09.03 Corrosion-Resisting Steel Bolts and Set Screws.** Fabricate bolts and screws from bars conforming to ASTM A 276. Use Types 302 or 304 for steel machine bolts to attach aluminum posts to concrete and for steel set screws for aluminum railings.

**813.09.04 Stainless Steel Hardware, Bolts, Nuts, and Washers.** Conform to ASTM A 320.

**813.09.05 Cadmium Coatings for Steel Anchor Bolts, Nuts, and Washers.** Conform to ASTM B 766, Class 12, Type II.

**813.10 WELDING MATERIAL, PROCEDURES, AND INSPECTION.** For bridges comply with the ANSI/AASHTO/AWS D1.5 Bridge Welding Code with modifications and additions as specified in the Plans.

For other steel structures comply with the AWS Structural Welding Code D1.1 with modifications and additions as specified in the Plans. For aluminum structures comply with the AWS Structural Welding Code-Aluminum D1.2.

**813.11 STUD SHEAR CONNECTORS.** Conform to AASHTO M 169 (ASTM A 108, Grade 1015).

## **813.12 HANDRAIL.**

**813.12.01 Type B.** Fabricate the channel, picket, and posts using hot rolled steel conforming to AISI M 1020; ASTM A 519, Grade 1020; ASTM A 575, Grade M 1020; or ASTM A 659, Grade 1020. For the lambs tongue, use either a gray iron casting or a commercial grade steel. After fabrication and cleaning, paint the handrail with 2 coats of commercial grade primer paint and one coat of commercial grade black enamel. Repaint



damaged areas as directed.

**813.12.02 Type C.** Furnish aluminum posts and rails conforming to ASTM B 221, alloy 6063, temper T52. Provide rails with a polished finish and posts and fittings with a satin finish. Use aluminum alloy fittings for handrails as recommended by the handrail manufacturer.

**813.13 MATTRESSES AND GABIONS.** Conform to ASTM A 975, Style 1. Use wire with a minimum elongation of 10 percent of the length of the wire when tested according to ASTM A 370 without reducing the diameter or tensile strength of the wire.

Supply lacing wire in sufficient quantity to ensure that all required tying, connecting, and lacing can be performed. For Department direct purchases, supply an amount of lacing wire equal to or greater than 8 percent of the weight of the units.

Fabricate the mattress units to the dimensions required by the Contract. The Department will accept mattresses with dimensions within  $\pm 3$  percent of the ordered width.

**813.13.01 Mattress Units.** As an alternate to lacing wire, the Engineer will allow mattress unit fasteners, from the Department's List of Approved Materials, that conform to mattress unit manufacturer's recommended assembly and connection instructions.

Subdivide the mattress units into compartments a maximum of 3 feet in length extending over the full width of the mattress unit by inserting diaphragms made of the same mesh as the rest of the mattress unit. Secure the diaphragms in position on the bottom with a continuous spiral wire at the factory so no additional tying at this joint is necessary.

**813.13.02 Gabion Baskets.** As an alternate to lacing wire, the Engineer will allow gabion unit fasteners, from the Department's List of Approved Materials, that conform to mattress unit manufacturer's recommended assembly and connection instructions.

Supply diaphragms of the same material composition as the gabion to form individual cells of equal length and width when the gabion length exceeds its width.

**813.13.03 Acceptance.** The Department will test each shipment for wire size and zinc coating, and will perform any other Engineer ordered tests. The Department will accept shipments based on laboratory testing and the Engineer's visual inspection.

## SECTION 814 — GUARDRAIL SYSTEMS

**814.01 DESCRIPTION.** This section covers material requirements for corrugated sheet steel beams and accessories for guardrail, terminal sections, guardrail posts, offset blocks, end treatments, and timber guard posts.

**814.02 BEAMS AND ACCESSORIES.** Conform to AASHTO M 180. Hardware for Type I, II, or III beams may be either hot-dip galvanized, electrogalvanized, or mechanically galvanized. Galvanize according to AASHTO M 232. The Engineer will reject beams with zinc oxide (white rust) in amounts deemed objectionable. Furnish Type II beams of either Class A, 0.105 inch thick or Class B, 0.135 inch thick as specified in the Contract.

**814.03 TERMINAL SECTIONS.** Conform to AASHTO M 180 and the details shown on the Standard Drawings. Galvanize sections after fabrication. Furnish Type 2 sections of either Class A, 0.105 inch thick or Class B, 0.135 inch thick as specified in the Contract.

**814.04 GUARDRAIL POSTS.** Provide either steel or timber, and use the same type throughout the Project.

**814.04.01 Steel Guardrail Posts.** Fabricate from steel conforming to AASHTO M 183 for the wide flange shapes and ASTM A 570 for C shapes except ensure that C shape posts have mechanical properties equal to those required by AASHTO M 183. Punch or drill holes for connector bolts before galvanizing. Galvanize all posts according to AASHTO M 111.

**814.04.02 Timber Guardrail Posts.** Furnish either square sawn or round timber guardrail posts. Conform to the nominal dimensions shown on the Standard Drawings. The Engineer will allow a minus 2-inch tolerance from the specified nominal length. Saw the butts of all posts square, and finish the tips as specified in the Contract.

Bore bolt holes to a driving fit for the bolts. Frame, bore, and trim, as much as is practical, before giving the posts a preservative treatment. When it is necessary to bore or cut the posts after treatment, or when any treated surface has been badly scarred, treat the cut or scarred surface according to AWP A M4.

Treat the posts with preservative according to AWP A C 14 as applicable for guardrail posts. Use only one type throughout the project unless otherwise approved by the Engineer.

Use any of the species of wood for round guardrail posts covered under AWP A C 5. Use any of the softwood species for square sawed posts covered under AWP A C 2. When furnishing oak posts, treat with creosote or creosote solution according to AWP A C 2 for "Above Ground, Soil or Fresh Water Exposure."

See Subsection 818.01 for inspection, testing and acceptance procedures for Timber Guardrail Posts.

- A) Square Sawed Posts.** Ensure the posts, in the direction parallel to the axis of the bolt holes, do not exceed the dimensions specified in the Contract by more than 1/4 inch.

Use posts that have straight grain, and that have a slope of the grain not deviating more than one inch in 12 inches from being parallel to any face when measured over the middle one-half of the length. The Engineer will not accept posts having a crook exceeding 1/2 inch in 10 feet. Limit wane to one end of the post only, and do not allow it to extend more than 10 feet from that end. Do not reduce the flat width of any face by more than 25 percent at the point of most wane. Do not use wood with ant tunnels, woodpecker holes, plugged holes, or any large unsightly gaps. The Department will allow wood with grub and worm

holes less than 1/2 inch in average diameter, provided that the sum of the diameters of all holes in any 12 inches of post length does not exceed 1/4 the nominal width of the face. Do not use posts showing signs of powder post beetle infestation. The Engineer will not limit the use of posts that have grub holes appearing entirely on the surface of the post and that do not penetrate to more than 1/2 inch in maximum depth.

Do not use posts with knots greater than 3/8 the nominal width of the face, measured by the smallest diameter. Do not allow the sum of the diameters of all knots in any 6 inches of post length to exceed 3/4 the nominal width of the face. Do not allow the sum of the diameter of all knots appearing within the middle half of the length of any face to be greater than 4 times the size of the largest knot allowed in that face. The Department will allow posts with unsound knots no larger than half the maximum allowable size for sound knots and no more than 1 1/2 inches in depth, provided that the surrounding wood is not affected by the decay. Do not use posts that have clusters of knots where the maximum distortion of the grain around the cluster exceeds the maximum allowable size for one knot.

Entirely confine shakes within the ends of the post, without extending to any face. Measure the shake as the sum of the 2 adjoining sides of the smallest rectangle that will completely enclose the shake. Measure the sides of the rectangle parallel to the faces of the post. Do not allow shakes to occur in more than one annual ring or to extend to more than 3/4 of the circumference of the annual ring in boxed heart. Do not allow total shake measurement to exceed one-half the width of the face.

Do not use posts with splits greater in length than the width of the face. Do not use posts with a check or series of contiguous checks having a width of 8 mm or greater at the surface and more than 3 inches in depth at any point and extending more than 3/4 of the length of the post from one end. The Engineer will determine the depth of checks by the penetration of a probe 1/64 inch thick and 1/4 inch wide. The Engineer will consider the extent of a check or series of contiguous checks to end at the last point where the opening does not exceed 1/8 inch in width and is no more than 3/4 inch in depth.

Do not use any post having a shake that does not exceed the maximum limits for shakes as specified herein, but contains a check which penetrates to the annual ring in which the shake occurs.

- B) Round Posts.** Peel all posts for their full length, and remove all outer and inner bark. Shave all knots and projections smooth and flush with the surface of the surrounding wood.

Ensure that the posts are a constant diameter not less than 1/4 inch under the nominal diameter.

Do not use posts that have short or reverse bends, one way sweeps exceeding one inch, and winding twists that are unsightly and exaggerated. The Engineer will not allow more than 10 percent of the number of pieces of any shipment to contain the maximum sweep.

Do not use posts with unsound, loose or hollow knots. The Department will allow use posts that have sound knots when the diameter of any one knot or when the combined diameters of 2 or more knots occurring in the same cross section are no greater than 1/3 of the diameter of the post at that cross section.

Ensure that posts are close grained and do not show spiral grain exceeding 1/8 turn in 5 feet.

Do not use posts with seasoning checks that penetrate the interior of the post to a depth greater than 1/3 of the diameter at any point, or which measure more than 1/4 inch in width at any point.

Do not use posts that have ring shakes, sap rot, bird pecks, insect holes, pitch pockets, or pitch streaks, and other defects that will impair the strength of the post, or give it an unsightly appearance.

**814.05 OFFSET BLOCKS.** Use the size, and when specified, the type the Contract specifies.

**814.05.01 Wood.** Conform to 814.04 for material properties.

**814.05.02 Composite Plastic.** Use blocks that are uniform in composition throughout the product and consist of at least 70 percent plastic by weight. Use sufficient additives to inhibit photo degradation. The Department will consider 2 percent carbon black to be a minimum. Ensure the blocks conform to the National Cooperative Highway Research Program (NCHRP) 350 Test Level 3 requirements.

Submit a written manufacturer's certification to the Engineer stating the material composition conforms to this subsection and is the same that was tested and approved under NCHRP 350.

**814.06 MATERIALS FOR END TREATMENTS.** Conform to Subsections 814.02 through 814.05 for common components, and, except where otherwise provided, ensure they are of the same class and type as required for the guardrail to which they are attached.

Galvanize all non-corrosion-resistant metals used in end treatments according to AASHTO M 111 or AASHTO M 232 as applicable. For other materials, comply with the following requirements:

**A) Anchorage Systems.** Furnish anchorage systems that have a minimum breaking strength of 40,000 pounds. The anchorage system may employ either a cable assembly or continuous steel rod or other system of equal or greater strength when approved. For cable assemblies, use cable that is 3/4-inch (6 by 19) wire rope conforming to AASHTO M 30, Class C. Provide swage fittings as required by the Standard Drawings and include studs as required. Ensure that eye bolts conform to ASTM A 489 and are of either Type 1 or Type 2. For wire rope clips use a commercial grade capable of being torqued to a minimum of 130 foot-pounds.

Use commercial grade wire rope thimbles.

**B) Anchor and Miscellaneous Plates.** Fabricate from steel conforming to Subsection 812.01.01.

**C) Miscellaneous Hardware.**

Bolts ASTM A 307

Nuts ASTM A 563, Grade A or better

**D) Steel Sheet (for rail plates and mounting brackets).** Conform to ASTM A 570, Grade D.

**E) Tubular Sections (for posts and blocks).** Conform to ASTM A 500, Grade B or ASTM A 501.

**F) Steel Drums.** For steel drums conform to Federal Specification PPP-D-729C for Type II, straight side, with rolled or expanded hoops, cylindrical drum; double seamed without chime reinforcement. Ensure that average diametrical crushing strength per drum is 6,000 pounds with maximum variation for 10 tests being 400 pounds. Galvanize steel drums on all surfaces according to AASHTO M 111.

**G) Concrete.** Conform to Section 601, Class A.

**H) Welded Wire Fabric.** Use welded wire fabric for concrete reinforcement that is W3 by W3, 6 by 6-inch conforming to Subsection 811.04. The Department may allow other approved types of steel reinforcement.

